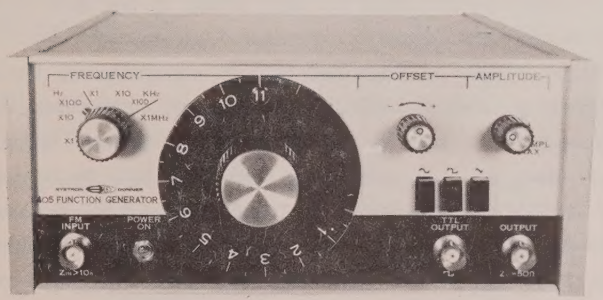
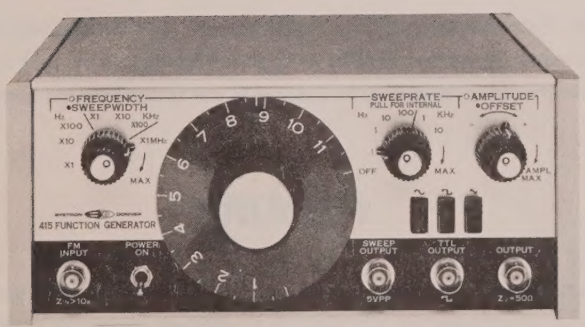
MODELS 405 and 415

SWEEP/FUNCTION GENERATORS

SYSTRON DONNER

INSTRUCTION MANUAL





MODELS 405 and 415

SWEEP/FUNCTION GENERATORS

SERIAL NO.

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SYSTRON DONNER CORPORATION

CONCORD INSTRUMENT DIVISION
10 Systron Drive • Concord, California 94518 • U.S.A.
Tel: (415) 676-5000 • TWX: 910-481-9479 • Cable: SYSTRONDONNER
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SYSTRON DONNER
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Neil Harrer

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PRE-SALE ASSISTANCE	DELIVERY	INSTRUMENT PERFORMANCE	INSTRUMENT QUALITY
☐ Excellent	☐ Early	☐ As Expected	☐ Excellent
☐ Fair	☐ On Time	☐ Good	☐ Fair
☐ Poor	☐ Late	☐ Defective	☐ Poor

SERVICE CONTRACT AFTER WARRANTY? ☐ Yes ☐ No ☐ Check Later

PROVISIONING PARTS REQUIRED? ☐ Yes ☐ No ☐ Check Later

THIS EQUIPMENT WAS TO: ☐ Replace existing instrument ☐ Expand equipment capability

WHAT INFLUENCED YOUR DECISION TO BUY? ☐ Advertising ☐ Salesman ☐ Other

COMMENTS: _____

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CHAPTER 1
GENERAL INFORMATION

1-1. INTRODUCTION.

This instruction manual contains the operation and maintenance information for the Systron-Donner Models 405 and 415 Sweep/Function Generators.

1-2. DESCRIPTION.

The Models 405 and 415 are compact function generators that provide sine, square, and triangular waveforms in the 0.01 Hz to 11 MHz frequency range. In addition, the Model 415 contains a sweep generator which may be used to frequency modulate the waveform generator over a 1000:1 ratio at sweep rates from 0.01 Hz to 10 kHz. Both models may be externally frequency modulated over a 1000:1 ratio.

1-3. SPECIFICATIONS.

Table 1-1 lists the specifications and leading particulars for the function generators.

TABLE 1-1. SPECIFICATIONS

FREQUENCY	
Range:	0.01 Hz to 11 MHz in seven overlapping decade steps.
Accuracy:	Better than ±3% of full scale (1% typical) to 1.1 MHz. Less than 5% of full scale from 1.0 to 11 MHz.
FREQUENCY MODULATION	
Sweep Ratio:	Greater than 1000:1.
Sensitivity:	Less than 0 to greater than +5V sweeps 1000:1.
Input Impedance:	Greater than 5 kΩ.
MAIN OUTPUT	
Waveforms:	Sine, square, and triangular.
Sine Distortion:	Less than 1% to 110 kHz. No harmonic greater than -30dB to 1.1 MHz, greater than -25dB to 11 MHz. (Measured between 1.0 and 11 on the dial at maximum amplitude).
Symmetry:	Greater than 98% to 1.1 MHz (between 1.0 and 11 on the dial).

TABLE 1-1. SPECIFICATIONS (CONTD)

MAIN OUTPUT (Contd)	
Square Wave Transition:	Approximately 20 nanoseconds.
Triangle Linearity:	Greater than 99% to 110 kHz (measured between 1.0 and 11 on the dial at maximum amplitude).
Amplitude:	Greater than 20V p-p maximum, (open circuit). 10V p-p maximum, into 50 or 600 ohms to 1.1 MHz, 16V p-p maximum (open circuit). 8V p-p maximum into 50 or 600 ohms to 11 MHz.
Attenuation:	Greater than 40dB range, continuously variable.
Impedance:	50 ohms (600 ohms by removing internal jumper).
DC Offset:	Continuously variable from -10V to +10V (open circuit), independent of attenuator setting. Greater than ±5V into 50 or 600 ohms. Combination of dc offset and signal limited to ±5V when terminated in 50 or 600 ohms.
SWEEP GENERATOR (Model 415 only)	
Sweep Rate:	0.01 Hz to 10 kHz in six decade ranges.
Sweep Ratio:	1000:1
Sweep Output:	5V p-p, fixed (baseline at ground) with upper frequency set by dial. Accuracy same as dial accuracy in nonswept operation.
TTL OUTPUT	0 to ≈+4V peak square wave, TTL compatible.
GENERAL	
Power:	100 to 125/200 to 250 Vac, 50 to 400 Hz at approximately 20W.
Dimensions:	
Height:	3-1/2 inches (8.9 cm)
Width:	8-3/8 inches (21.3 cm)
Depth:	12-5/8 inches (32.1 cm)
Weight:	7.5 lbs (3.4 kg) net, 10 lbs (4.5 kg) shipping.

CHAPTER 2
INSTALLATION

2-1. INTRODUCTION.

The Models 405 and 415 Sweep/Function Generators are shipped in an operational condition and are essentially ready for use as received. This chapter outlines the procedures for initial inspection and installation of the instruments. Instructions for reshipment are also included should an instrument be returned to Systron-Donner Corporation for service or repair.

2-2. RECEIVING INSPECTION.

Prior to accepting an instrument from the shipper, inspect the condition of the shipping container for any indication of freight damage. Any sign of such damage must be noted by both the shipper and receiver and should be reported to the carrier.

Immediately following removal of an instrument from the shipping carton, inspect for possible physical damage incurred during shipment. Check surfaces for scratches or dents and note condition of knobs and connectors. Should any damage be noted, notify your nearest Systron-Donner representative --- DO NOT USE THE INSTRUMENT UNTIL INSTRUCTED TO DO SO BY THE REPRESENTATIVE.

2-3. RESHIPMENT.

When an instrument is to be repackaged for shipment, use the original packing materials. Your Systron-Donner field office can provide materials similar to that used for the original factory packaging, or repackage the instrument as follows:

1. Attach a tag to the instrument indicating the model number, serial number, and name and address of the instrument owner, and a summary of the service or repairs required.

2. Wrap the instrument in heavy paper or plastic prior to placing it into the shipping container.

3. Select a strong carton or wooden box to house the instrument.

4. Use an adequate layer of shock-absorbing material on all sides of the instrument and protect the front panel with additional layers of cardboard. Be certain that there is no movement of the unit within the container.

5. Seal the package with strong tape or metal bands.

6. Mark the shipping container "FRAGILE-DELICATE INSTRUMENT" to ensure careful handling.

7. Be certain that all correspondence refers to full instrument nomenclature (model and serial number).

2-4. POWER REQUIREMENTS.

The Models 405 and 415 Sweep/Function Generators are equipped with a standard three-conductor power cord which, when plugged into an appropriate power receptacle, grounds the chassis to protect operating personnel from certain electrical hazards. Whenever the power cord is mated to a two-conductor outlet, a cord adapter-plug (properly installed) will provide the same protection.

The instruments operate from 100/200, 115/230, or 125/250 volts ac at 50 to 400 Hz. A LINE switch on the rear panel selects either 115 or 230 volts and taps on the primary of the power transformer are provided to accommodate the other power line requirements.

If 100/200 or 125/250 volts ac are required for operation, be sure to connect the input power lines to the appropriate taps on transformer T501. (See power supply schematic diagram to figure 6-3).

CAUTION

Do not energize the instrument before checking line power requirements or equipment damage may result.

To connect for 100/200 volt operation, proceed as follows:

1. On power transformer, replace BLK/YEL wire with BLK/WHT wire.
2. Replace BRN/YEL wire with BRN/WHT wire.
3. Set LINE switch to appropriate high- or low-voltage position. (For example, if 100 volts ac is to be used, set LINE switch to 115V).

To connect for 125/250 volt operation, proceed as follows:

1. On power transformer, replace BLK/YEL wire with BLK/RED wire.
2. Replace BRN/YEL wire with BRN/RED wire.
3. Set LINE switch to appropriate high- or low-voltage position. (For example, if 125 volts ac is to be used, set LINE switch to 115V).

2-5. RACK MOUNTING SET INSTALLATION.

When rack mount set Type 1009 is supplied, install as follows:

1. Assemble handles (No. 0) to rack mount end trim (No. 11) and extension panel (No. 15) using flush head screws (No. 5). (See figure 2-1).
2. Remove screws from front end block where extension panel (No. 15) is to be fastened. Leave end block in place and fasten angle bracket (No. 13) to it, using round head screws (No. 3). Fasten extension panel (No. 15) to angle bracket (No. 13) using round head screws (No.2) and kep nuts (No. 7).
3. Replace remaining front end block with handle assembly (refer to step No. 1).

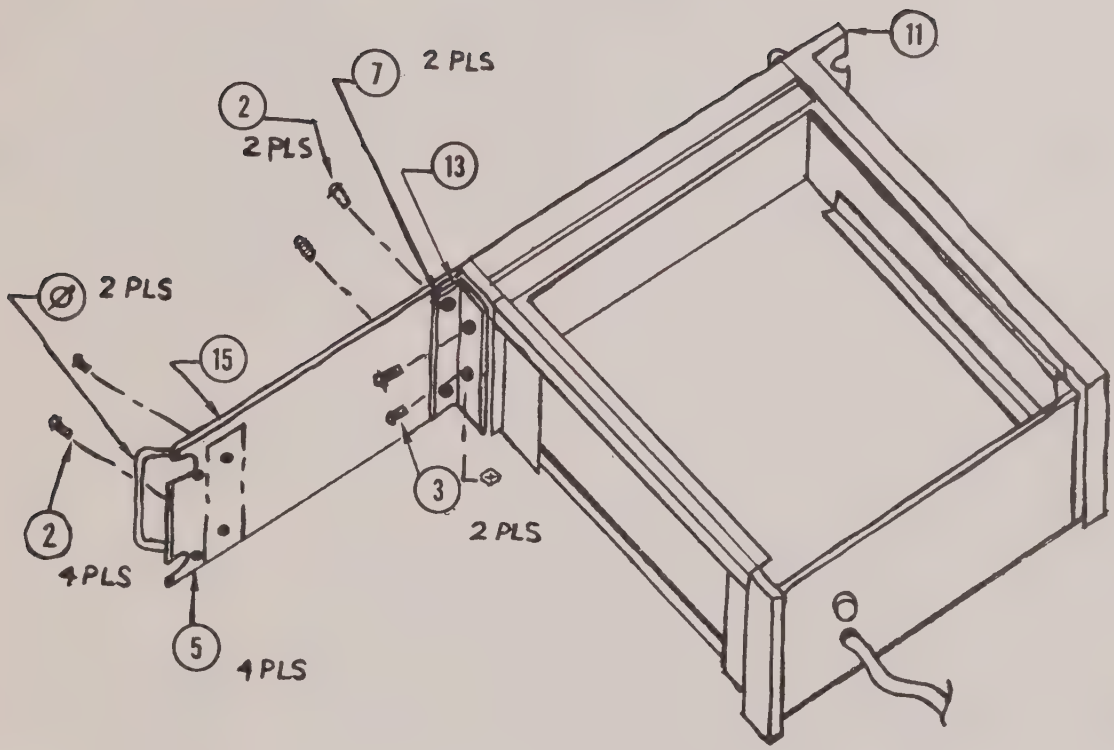


FIGURE 2-1. TYPE 1009 RACK MOUNTING SET

CHAPTER 3
OPERATION

3-1. INTRODUCTION.

This chapter describes general operation of the Models 405 and 415 Sweep/Function Generators. Controls, indicators, and connectors are depicted and described.

3-2. CONTROLS AND CONNECTORS.

Figures 3-1 and 3-2 depict the controls and connectors. Tables 3-1 and 3-2 describe the functions of the controls and connectors.

TABLE 3-1. MODEL 405 CONTROLS AND CONNECTORS

Fig. 3-1 Index No.	Control or Connector	Function
1	FREQUENCY selector	Selects one of seven frequency ranges.
2	FREQUENCY dial	Continuously varies the frequency between upper and lower limits of range selected by the FREQUENCY selector.
3	OFFSET control	Adjust the output waveform offset in either a positive or negative direction.
4	AMPLITUDE control	Continuously adjusts the amplitude of the output waveform from 0 to 20V p-p maximum.
5	Waveform selectors	Three interlocking pushbutton switches that select desired waveform type, sine-wave (∿), squarewave (⊓⊔), or triangle (⩘).
6	OUTPUT connector	Main output connector for sine, square or triangle waveform. Output impedance is 50 ohms or 600 Ω by removal of internal jumper.
7	TTL OUTPUT connector	Provides a 0- to 4-volt squarewave output with baseline at ground for synchronization purposes.
8	POWER ON switch	Applies ac voltage to the primary of the power transformer.
9	FM INPUT connector	Provides input for external frequency modulation signal.

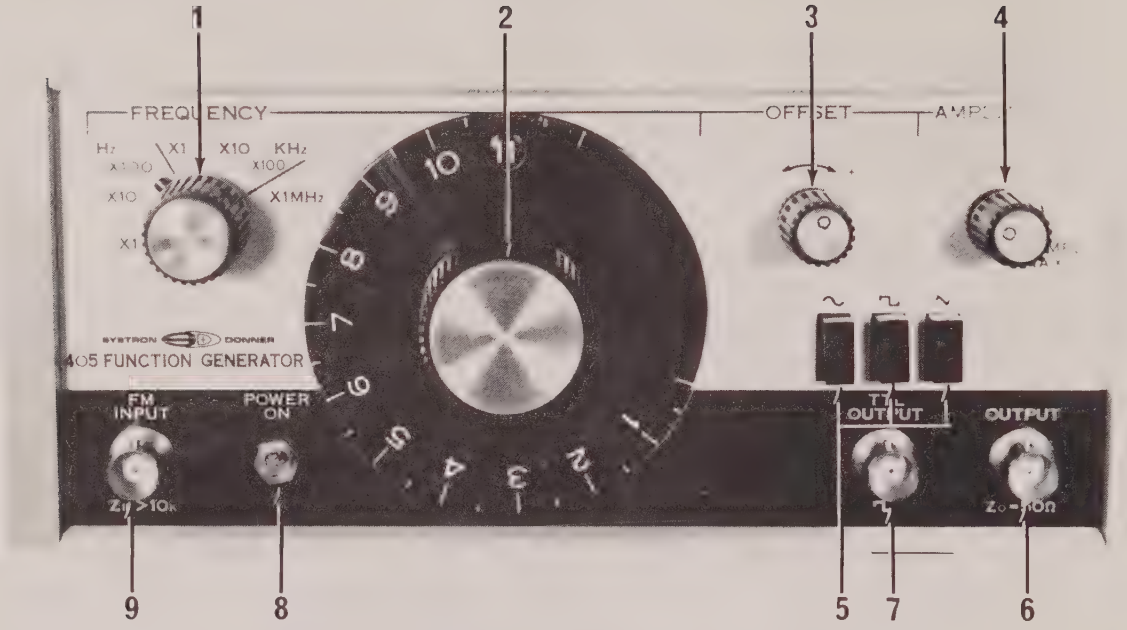


FIGURE 3-1. MODEL 405 CONTROLS AND CONNECTORS

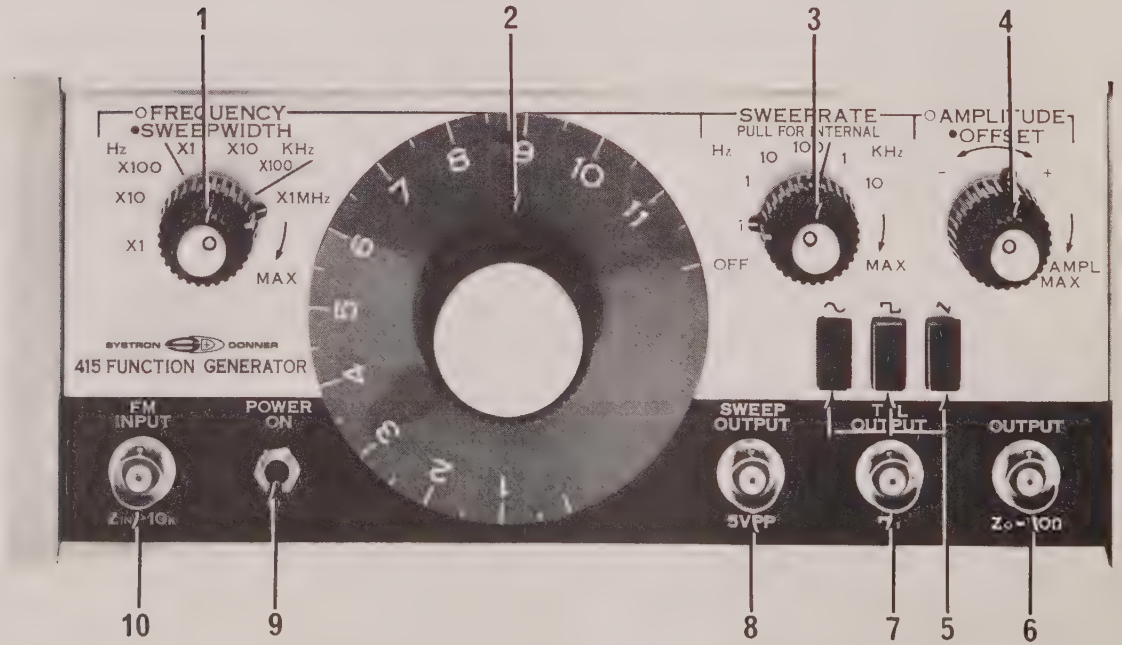


FIGURE 3-2. MODEL 415 CONTROLS AND CONNECTORS

TABLE 3-2. MODEL 415 CONTROLS AND CONNECTORS

Fig. 3-2 Index No.	Control or Connector	Function
1	○ FREQUENCY ● SWEEP WIDTH selectors	Concentric switches that select frequency and sweepwidth ranges. The FREQUENCY control (outer) selects one of seven overlapping decade frequency ranges. The SWEEPWIDTH control (inner) selects the range of the frequency to be swept.
2	FREQUENCY dial	Continuously varies the frequency within the range selected by the FREQUENCY selector.
3	SWEEP RATE controls	Concentric selector switch with vernier. The outer switch selects range. When set to OFF, sweep circuit is disabled. The vernier provides a continuous variation of repetition rate within each range. When pulled out, the vernier sets the instrument for internal sweep operation.
4	○ AMPLITUDE ● OFFSET	Concentric verniers that continuously adjust waveform offset and amplitude.
5	Waveform selectors	Three interlocking pushbutton switches that select desired waveform output, sinewave (∿), squarewave (⊓⊔), or triangle (⩘).
6	OUTPUT connector	Main output for sine, square, triangle waveform. Output impedance is 50 ohms or 600 Ω by removal of internal jumper.
7	TTL OUTPUT connector	Provides a 0 to 4-volt squarewave output with baseline at ground for synchronization purposes.
8	SWEEP OUTPUT connector	Provides a 5-volt peak-to-peak ramp at the selected sweep rate. Output impedance is 600 ohms.
9	POWER ON switch	Applies ac voltage to the primary of the power transformer.
10	FM INPUT connector	Provides input for external frequency modulation signal.

NOTE: ○ denotes outerconcentric; ● denotes innerconcentric.

3-3. OPERATIONAL CHECKOUT.

The following procedures provide a check of the function generators to ensure that the instruments are operating properly.

NOTE

Allow one-half hour warmup before proceeding with the procedures.

3-4. TEST EQUIPMENT REQUIRED.

The following test equipment, or equivalents, are required for the checkout procedures:

1. Oscilloscope, Teletronix Model 453
2. Electronic Counter, Systron-Donner Model 6251
3. Coaxial Termination, 2 watt
4. Two coaxial cables with BNC connectors terminated into 50 ohms

3-5. OUTPUT WAVEFORM CHECK.

To check the sine, square, and triangle output waveforms, proceed as follows:

1. Connect function generator OUTPUT connector to oscilloscope vertical input using terminated coaxial cable. Connect function generator TTL OUTPUT to oscilloscope sync input.
2. On function generator, set controls as follows:
   a. POWER switch to ON
   b. FREQUENCY control to X100 kHz
   c. FREQUENCY dial to 11
   d. OFFSET vernier to mid-point
   e. AMPLITUDE vernier maximum clockwise
   f. Press Squarewave (⊓⊔) pushbutton

NOTE

Adjust AMPLITUDE vernier as necessary to obtain a proper display of approximately 10 volts peak-to-peak.

3. Observe oscilloscope. Display should be a squarewave approximately 10 volts peak-to-peak.
4. Press triangle waveform (∿) pushbutton and observe oscilloscope. Display should be triangular waveform approximately 10 volts peak-to-peak.

5. Press sinewave (∿) pushbutton and observe oscilloscope. Display should be sinewave approximately 10 volts peak-to-peak.

3-6. FREQUENCY CHECK.

To check the frequency range of the function generator, proceed as follows:

1. On function generator, connect TTL OUTPUT connector to counter input.
2. On function generator, set controls as follows:
   a. POWER switch to ON
   b. OFFSET vernier to midpoint
   c. AMPLITUDE vernier fully clockwise
3. SET FREQUENCY control to X1 MHz and FREQUENCY dial to 11. Counter should indicate frequency between 10.45 and 11.55 MHz.
4. Repeat step 3 for each range using the following control settings and counter indications:

FREQUENCY Control Setting	FREQUENCY Dial Set to 1	FREQUENCY Dial Set to 11
	Frequency/Period	Frequency/Period
X1 MHz	.45 to 1.55 MHz	10.45 to 11.55 MHz
X100 kHz	0.67 to 133 kHz	1.067 to 1.133 MHz
X10 kHz	6.7 to 13.3 kHz/0.140 to 0.075 ms	106.7 to 113.3 kHz/ 9.3 to 8.83 µs
X1 kHz	0.67 to 1.33 kHz/1.49 to 0.75 ms	10.67 to 11.33 kHz/93 to 88 µs
X100 Hz	67 to 133 Hz/14.9 to 7.5 ms	1.067 to 1.133 kHz/0.94 to 0.88 ms
X10 Hz	6.7 to 13.3 Hz/0.149 to 0.075s	105.7 to 113.3 Hz/9.4 to 8.8 ms
X1 Hz	0.67 to 1.33 Hz/1.49 to 0.75s	10.67 to 11.33 Hz/93.7 to 88.3 ms

3-7. SWEEP CHECK (MODEL 415 ONLY).

To perform the sweep check proceed as follows:

1. On the function generator, set control as follows:
   a. POWER switch to ON
   b. SWEEP RATE range selector to 10 kHz
   c. SWEEP RATE vernier to MAX (fully clockwise)
2. Connect SWEEP OUTPUT to oscilloscope vertical input through coaxial cable.
3. Observe oscilloscope. Ramp signal should be 5 volts peak-to-peak (starting at ground) with a repetition rate of 10 kHz..
4. Rotate SWEEP RATE vernier fully counter clockwise. Repetition rate should be less than 1 kHz.

5. Set SWEEP RATE range selector and vernier as listed below and observe for repetition rates:

SWEEP RATE Range	SWEEP RATE Vernier Fully CCW	SWEEP RATE Vernier Fully CCW
10 kHz	Less than 1 kHz	Greater than 10 kHz
1 kHz	Less than 100 Hz	Greater than 1 kHz
100 Hz	Less than 10 Hz	Greater than 100 Hz
10 Hz	Less than 1 Hz	Greater than 10 Hz
1 Hz	Less than 0.1 Hz	Greater than 1 Hz
0.1 Hz	Less than 0.01 Hz	Greater than 0.1 Hz

6. On the function generator, set controls as follows:

   a. FREQUENCY range selector to X1 MHz

   b. FREQUENCY dial to 11

   c. OFFSET vernier to mid-range

   d. Amplitude vernier to mid-range

   e. SWEEP RATE range to 1 Hz

   f. SWEEP RATE vernier fully clockwise and pulled outward

   g. SWEEP WIDTH control to mid-range

7. Set oscilloscope sweep rate to 5 microseconds per division. Note frequency changes at the sweep rate. Observe that rotating SWEEP WIDTH control varies the amount of frequency change.

CHAPTER 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

This chapter describes the principles of operation of the Models 405 and 415 Function/Sweep Generators from two different perspectives. The overall function operation at a functional block diagram level is discussed first and is supported by figure 4-1 Models 405 and 415 Functional Block Diagram located on page 4-1. A detailed description of the theory of operation at the circuit level follows and is supported by the schematic diagrams located in chapter 6 of this manual.

4-2. OVERALL FUNCTIONAL DESCRIPTION.

Physically and functionally the Models 405 and 415 are divided into five basic functional sections. Table 4-1 provides a listing of the function sections as to their title (common name), assembly number, related figure and drawing numbers of the schematic diagrams, and their page location within the manual.

TABLE 4-1. MODELS 405 and 415 FUNCTIONAL ASSEMBLIES

ASSEMBLY NAME AND NO.	SCHEMATIC NO.	FIGURE NO.	PAGE NO.
Front Panel Assy. #113044	None	None	None
Main PCB Assy. #11305801	113050	6-1	6-3/6-4
Sweep Generator P/O Assy. #11305801 (Model 415 only)	113603	6-2	6-5/6-6
Power Supply P/O Assys. #11305801 and #113055	113106	6-3	6-7/6-8
Rear Panel Assy. #113055	None	None	None

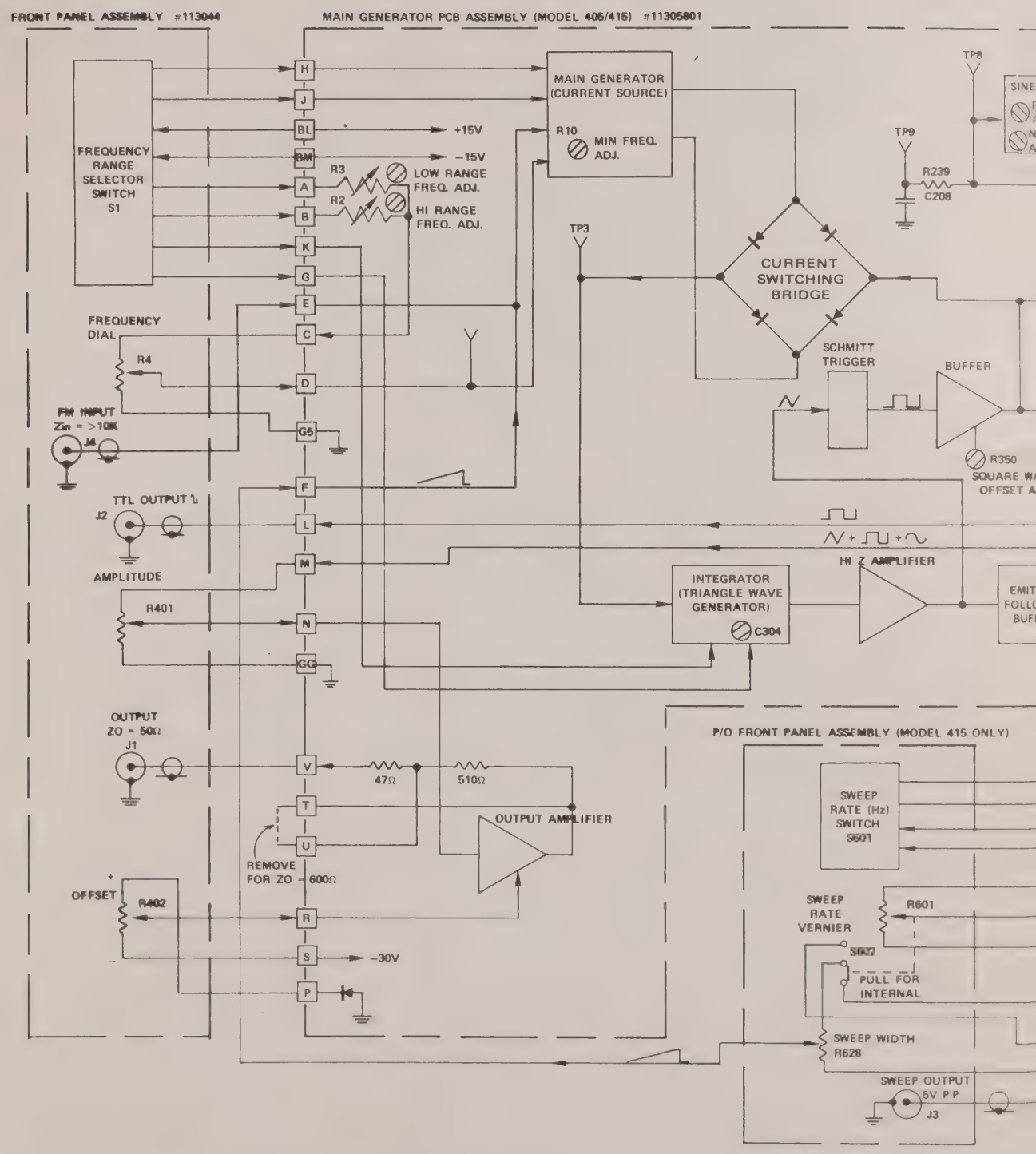
4.2.1. Main Generator Functional Circuits.

The main generator develops the sine, square and triangle waveforms.

The frequency determing circuits are the Main Generator (Current Source) and the interfacing front panel FREQUENCY RANGE selector switch (S1) and FREQUENCY DIAL (R4). Adjustments mounted on the Main PCB assembly provide for calibration of the frequency ranges overlaps, upper and lower limits, and minimum frequency, parameters. A bridge network isolates and fans out the current source selected frequency signals to the TTL output chain and the function generation chains.

4.2.2. TTL Output and Triangle Waveshape Chain.

The bridge output referenced at test point TP3, feeds the integrating capacitance at the input of a high impedance amplifier, which in turn triggers the TTL Schmitt trigger circuit generating a square wave. This square wave is buffered and emitter follower driven as a 0- to 4-volt TTL compatible external trigger. It is then routed via pad L to the front panels TTL OUTPUT ⌐⌙ BNC connector J2.


FRONT PANEL ASSEMBLY #113044
MAIN GENERATOR PCB ASSEMBLY (MODEL 405/415) #11305801
FREQUENCY RANGE SELECTOR SWITCH S1
H
J
BL
+15V
BM
−15V
R3
LOW RANGE FREQ. ADJ.
A
R2
HI RANGE FREQ. ADJ.
B
K
G
E
C
FREQUENCY DIAL
R4
D
FM INPUT Zin = >10K
J4
G5
F
TTL OUTPUT
J2
L
M
AMPLITUDE
R401
N
GG
OUTPUT ZO = 50Ω
J1
V
47Ω
510Ω
T
OUTPUT AMPLIFIER
U
REMOVE FOR ZO = 600Ω
OFFSET
R402
R
S
−30V
P
MAIN GENERATOR (CURRENT SOURCE)
R10
MIN FREQ. ADJ.
TP3
CURRENT SWITCHING BRIDGE
TP8
TP9
R239
C208
SCHMITT TRIGGER
BUFFER
R350
SQUARE W/ OFFSET A
HI Z AMPLIFIER
INTEGRATOR (TRIANGLE WAVE GENERATOR)
C304
P/O FRONT PANEL ASSEMBLY (MODEL 415 ONLY)
SWEEP RATE (Hz) SWITCH S601
SWEEP RATE VERNIER
R601
S602
PULL FOR INTERNAL
SWEEP WIDTH R628
SWEEP OUTPUT 5V P-P
J3

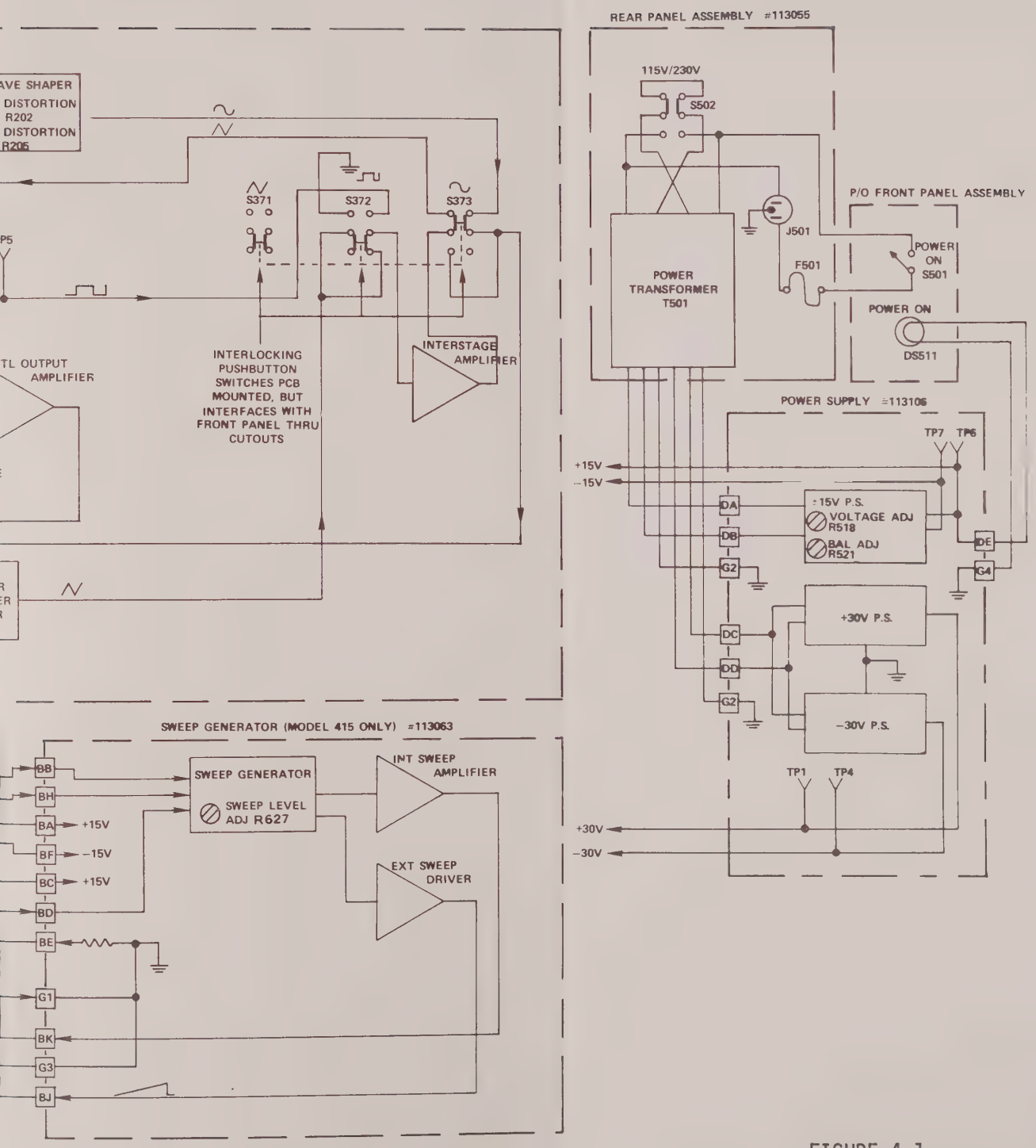


FIGURE 4-1.
405/415 FUNCTIONAL BLOCK DIAGRAM

The bridge output at TP3 also feeds the Triangle Wave Generator circuit which integrates the switched currents into a triangle wave shape. The FREQUENCY switch S1 selects the proper resistance values, which in consort with circuit capacitance and trimmer C304 generate the triangular wave form. When the Triangle (⩘) pushbutton switch and S371 is pressed, it routes the triangle signal via S372, the Interstage Amplifier and S373 to pad M. The above described routing is accomplished due to the mechanical interlocking of switches S371, S372 and S373.

4.2.3. Sine and Square Wave Chain.

The bridge switching input drive referenced at test point TP5 is produced by the Square Wave Shaper Circuit, which developes transition times (rise and fall) to approximately 20 nonoseconds. A Square wave offset adjustment R350 provides for zeroing out any offset. The square wave output is routed to the Interstage Amplifier when the square wave (⊓⊔) pushbutton switch S372 is pressed, and then outputted to pad M via S373, due to switch interlock action.

When the sine wave (∿) switch S372 is pressed the triangle signal is routed via S372, the Interstage Amplifier and S373 to the Sine Wave Shaper. This circuit converts the triangle signal into a sine wave. Two adjustments are provided: Negative and Positive Distortion adjustments (R205 and R202) to true up the sine wave.

4.2.4. Output Amplifier, Amplitude and Offset Control Circuits.

The triangular (⩘), square (⊓⊔) and the sine (∿) signals that are selected and generated are outputted at pad M then applied to the front panel AMPLITUDE control R401. The swinger of R401 inputs into the Output Amplifier circuit via pad N. The output is then routed via pad V to the front panel OUTPUT Zo = 50Ω BNC connector. The removal of the jumper between pads T and U will convert the output impedance to 600 ohms (Zo = 600Ω).

Offset of the output functions is provided by the (+) - (-) OFFSET control, which is front panel mounted and supplies a variable negative voltage via pad R to the Output Amplifier circuits. This control will continuously vary the offset from -10V to +10V (open circuit), independently of the AMPLITUDE control. A combination of dc-offset and amplitude control setting limit the output signal to ±5 volts when terminated into 50 or 600 ohms.

4-3. SWEEP GENERATOR FUNCTIONS (MODEL 415 ONLY).

The Model 415 is basically a Model 405 function generator with sweep generation circuits added. Two additional multifunction controls that are front panel mounted, and a BNC front panel mounted connector to provide the sweep output is also provided. The SWEEP RATE switch S601 is a six decade selector covering a range from 0.1 Hz to 10 kHz to control the sweep generator frequency. An innerconcentric control provides the vernier control of the sweep rate as a continuous variation with range overlap. When this control is pulled out the instrument is set for internal sweep operation.

A SWEEP WIDTH control R628 is added as the innerconcentric to the FREQUENCY selector switch S1 and allows adjustment of the frequency range being swept.

The sweep generator circuit is provided with one internal PCB mounted adjustment SWEEP LEVEL ADJ R627 which sets the amplitude of the sweep ramp.

Two output sweep amplifiers provide to internal and external sweep drive. The internal sweep drive amplifier outputs via pad BK to the PULL FOR INTERNAL switch S602 which is connected to the SWEEP WIDTH front panel control. This control's swinger is inputted to the Main Generator (Current Source) via pad F (see signal line denoted SWEEP). The external sweep drive amplifier outputs via pad BJ to the front panels SWEEP OUTPUT 5V p-p BNC connector.

4-4. DETAILED CIRCUIT DESCRIPTIONS.

4.4.1. Main Generator (Current Source).

The frequency of the Model 405/415 Function/Sweep Generators are controlled by applying step and variable positive and/or negative voltage levels. These voltage levels are developed by the selection of ranging resistors by the FREQUENCY switch S1 and the FREQUENCY dial potentiometer R4. Variable level signals from the FM INPUT BNC connector J4 via pad E, or the sweep (ramp) signal (Model 415 only) via pad F can also control (modulate) the current source circuits. The frequency control voltages and summed at the (+) input of operational amplifier U1. The output of U1 is coupled to the (+) input of operational amplifier U3, which in turn feeds the negative current control FET Q4 via Q2, U5 and the selected ranging resistor. The positive current is controlled by a variable signal from the emitter of Q2, which is applied to Q1 and the (-) input of U2. Operational amplifier U2 and Q1 provides the control of the main generators minimum frequency and symmetry setup via adjustment potentiometers R10 and R15.

The positive current control FET Q3 then FET gate driven by U4 and FET source controlled by the selected ranging resistor.

The currents developed by FET's Q3 and Q4 are applied to the switching bridge network (CR342 through CR345 and Q344 through Q347), and alternately switched to the integrator circuit by the square wave applied to the junction of Q345 and Q347 (TP5). The current source output to the integrator circuit (junction of Q344 and Q346) can be monitored at TP3).

4.4.2. Integrator (Triangle Wave Generation).

The integrator circuit consists of transistor-switch selected capacitors C302, 303, and C312 and capacitors C304 and C311. Transistor switch Q301 is activated on the three lower frequency ranges and Q305 on the middle three ranges. On the highest range both Q301 and Q305 are turned off leaving only C311 and trimmer C304 as the integrating capacitance. Thus, the approximate values of the integrating capacitance are: Low Ranges .5 µF, Middle Ranges 600 pF, and Highest Range 50 pF.

4.4.3. High Impedance Amplifier and Triangle Wave Drive Circuits.

FET Amplifier Q302 provides the high impedance input of the triganle wave amplifier circuits. Complimentary emitter followers Q307 and Q308 output the triangle wave train to the selector switch S372, for output selection, or routing to the sine wave shaper circuit. The amplifier configuration of Q303, Q304 and Q305 outputs to the Schmitt trigger to allow for the generation of square waves.

4.4.4. Square Wave Generation and Drive Circuits.

The Schmitt trigger is comprised of three elements of IC U321 and Q321. Output at pin 14 of U321 provides the current source for the bi-stable Schmitt trigger multi-

vibrator, which is configured by the elements pin 1 and 5 of U321. Resistors R325, R326, R334 and capacitor C326 are factory selected to provide a 50% duty cycle of greater than 98% symmetry at 110 kHz. Diodes CR321 and CR325 are provided for temperature compensation of Q321. Buffer amplifier Q341 outputs the square wave to emitter follower Q343 which in turn feeds the mode function selector switch S372 (pin 6) to allow for the selection of the square wave output function. Adjustment potentiometer R350 provides a means for zeroing out any offset of the square wave. Buffer amplifier Q342 feeds the output complimentary emitter followers Q361 and Q362. Q362. The common emitters output via pad L to the front panel BNC connector J2 (TTL OUTPUT⌐⌐), this signal is a TTL compatible 0 to 4 volt square wave that can be used to trigger external equipment.

4.4.5. Sine Wave Shaper Circuit.

The sine wave shaper circuit converts the triangle wave train into a sine wave. Operational amplifier U201 and emitter follower Q201 comprise the positive voltage source for the shaper ladder. Potentiometer R202 adjusts the level of the positive voltage source and is set to obtain minimum distortion of the positive half cycle of the sine wave. The negative voltage source for the shaper ladder is configured by operational amplifier U202 and emitter follower Q202. Potentiometer R205 is adjusted at test for minimum distortion of the negative half cycle of the sine wave.

The sine wave shpaing ladder functions as a logarithmically increasing impedance transmission line which in effect rounds off the inputted triangle wave to a true sine wave, having sine distortion of less than 1% up to a frequency of 110 kHz. Harmonic generation is no greater than -25 dB over the full frequency range of the instrument.

4.4.6. Interstage Amplifier and Function Selection Switching.

The function select switches S371, S372 and S373 are interlocked and operate with the interstage circuit, to select the required function, and route it at the proper voltage level to the output amplifier circuits.

When the∿ switch S371 is pressed and latched, it unlatches switches S372 and S373, thus allowing a routing of the triangle wave through S372, the interstage amplifier S373 and R389 (see figure 4-2 Function Selection Routing Diagram).

When the⌐⌐switch S372 is pressed and latched, switches S371 and S373 unlatch, which allows the square wave to be routed through S372, the interstage amplifier S373 and R389. The triangle wave is coupled to ground by S372 and R370, to prevent any inter-circuit coupling of the triangle wave when the square wave function is selected.

The selection of the sine function is configured when switch S373 is pressed and latched and S371 and S372 are unlatched. This configuration allows the triangle wave to be routed via S372, the interstage amplifier, S373, to the sine wave shaper. The sine wave shaper converte the triangle wave to a sine wave and outputs it through S373 bypassing R389. Resistor R389 is bypassed during sine function selection to correct for the attenuation of the sine shaper circuit. When the triangle or square wave function is selected the signal is routed out through R389. This selection of R389 allows amplitude equalization of all three functions.

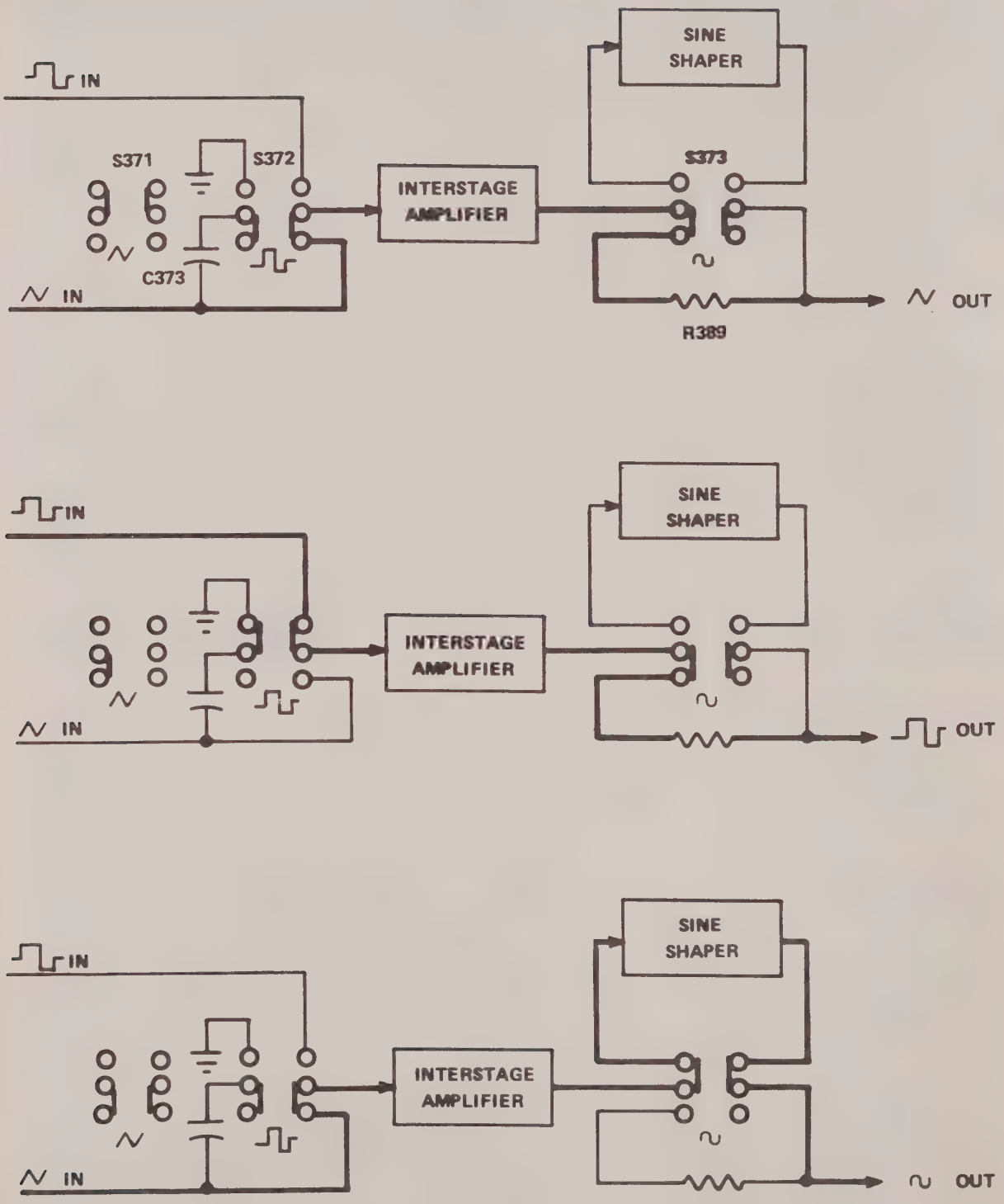


FIGURE 4-2. FUNCTION SELECTION ROUTING DIAGRAM

4.4.7. Output Amplifier Circuit.

The selected function signal output from function selector switch S373 is routed via pad M to the front panel AMPLITUDE control R401. The swinger of R401 inputs to Q401 via pad N, to provide a manually controlled input level to the output amplifier circuit. Due to the output amplifier circuit overall gain, a 0 to 20 volt peak-to-peak open circuit output of the selected function is provided for by the AMPLITUDE control. A front panel OFFSET control R402 interfaces via pad R with Q402 to provide a continuosuly variable dc offset of the outputted function signal from -10 volts to +10 volts (into an open circuit). The output drive is provided by two complimentary emitter followers Q405 and Q406 which outputs to the front panel BNC connector J1 via the configuration of pads T, U, and V. The removal of the jumper between pads T and U places a 510 Ω resistor R422 in series with R423 and the output connector, thus allowing output impedance to be changed from 50 Ω to 600 Ω. Frequency rolloff and output loading will effect the amplitude of the main output at J1, refer to table 1-1 in chapter 1 of the manual under Specifications; Amplitude for detailed information.

4.4.8. Sweep Generation Circuits (Model 415 Only).

The sweep generation circuit is basically a free-running voltage controlled ramp generator. Switch S601 SWEEP RATE selector, provides six decade step voltage levels, to the voltage control circuit comprised of U601 and Q601. The SWEEP RATE vernier R602 allows continuous variation within each selected decade step, by applying a manually controlled voltage level to the voltage control amplifier U601. Two outputs from the ramp generator are provdied; one is from emitter follower Q605 and is outputted via pad BJ to the front panel SWEEP OUTPUT 5V P-P BNC connector J3, the other output is from the unity gain isolation amplifier U604 to switch S602. The PULL FOR INTERNAL switch S602 is manually operated by pulling the SWEEP RATE vernier outward, and allows the ramp signal to be applied to the function generator for FM modulation. SWEEP WIDTH control R628 will adjust the amplitude of the ramp signal, and in effect controls the range of the frequency to be swept.

CHAPTER 5
CALIBRATION

5-1. INTRODUCTION.

This chapter provides calibration and alignment procedures for the Models 405 and 415 Function/Sweep Generators.

5-2. TEST EQUIPMENT REQUIRED.

The following test equipments (or equivalents) are required for proper alignment and calibration of the Model 405 and/or Model 415.

1. Oscilloscope, Tektronix Type 453 series
2. Electronic Counter, Systron-Donner Model 6251
3. Coaxial Termination 2 watt, Systron-Donner 452
4. Two 12 inch coaxial cables with BNC connectors terminated at 50 ohms, Systron-Donner part Number 36000-157
5. Digital Multimeter, Systron-Donner Model 7004
6. Distortion Analyzer, Hewlett Packard Model 33.

5-3. POWER SUPPLY ADJUSTMENTS.

To adjust the power supply proceed as follows:

1. Connect DMM probe to test point TP7 (-15V)
2. Adjust potentiometer R518 (Voltage Adj.) for -15V (±10 mV)
3. Connect DMM test probe to test point TP6 (+15V)
4. Adjust potentiometer R521 for +15V (±10 mV)
5. Repeat steps 1 thru 4 as necessary to obtain correct supply output voltages
6. Connect DMM test probe to test point TP1 (+30V) and verify an indication of +30V (±0.3V). If indication is incorrect see figure 6-3 Power Supply Schematic Diagram #113106, and take corrective maintenance action before proceeding.
7. Connect DMM test probe to test point TP4 (-30V) and verify an indication of -30V (±0.3V). If indication is incorrect see figure 6-3 Power Supply Schematic Diagram #113106 and take corrective maintenance action
8. Vary the line voltage ±10% and verify that following supplies maintain the following tolerances:

   ±15 volt power supplies ±15 mV

   ±30 volt power supplies ±30 mV

9. With the use of an oscilloscope check ripple on all four power supplies. With a line voltage variation of ±10%, ripple should not exceed 15 millivolts peak-to-peak.

5-4. MAIN GENERATOR CALIBRATION.

1. Configure instrument controls as follows:

CONTROL	POSITION OR SETTING
● OFFSET vernier	mid-point
○ AMPLITUDE vernier	mid-point
⊓⊔ (square wave) selector pushbutton switch	press (on)
POWER ON switch	up (on)

2. Connect instrument OUTPUT Zo = 50Ω connector with coax cable to oscilloscope vertical input; and terminate at oscilloscope with 50Ω coax termination.

3. Connect TTL OUTPUT⊓⊔ connector to counter input

4. Set FREQUENCY selector to X10 kHz and rotate FREQUENCY dial fully CW (lowest frequency). Adjust MIN FREQ ADJ potentiometer R10 for a counter display of 100 Hz (frequency), 10 ms (period).

5. Observe square wave on oscilloscope and adjust SYMMETRY ADJ potentiometer R15 to achieve 50% duty cycle.

6. Repeat steps 4 and 5 until frequency is approximately 1 kHz and duty cycle is 50%, (interaction of R10 and R15 requires repeating of steps 4 and 5).

5-5. FREQUENCY DIAL CALIBRATION.

In the event that the FREQUENCY dial should become loosened, or if for any other reason the unit cannot be properly calibrated, it will be necessary to reset the FREQUENCY dial on its shaft in accordance with the procedure outlined in steps 1 through 7. If the dial has not become loosened on its shaft start with step 8 after adjusting potentiometer R3 as stated in step 5.

1. Set the FREQUENCY selector to X100 Hz, connect TTL OUTPUT ⊔⊓⊔connector to a counter input

2. Adjust potentiometer R3 for a reading of ±10 volts at pad C on the PCB.

3. Adjust potentiometer R4 for a 100 Hz reading on the counter.

4. Being very careful not to twist the dial shaft, loosen allen screws holding the dial to the shaft and align the "1" mark with the index line on the front panel. Lightly tighten one of the allen set screws and verify that the dial is at the "1" mark and the counter reads 100 Hz.

5. Rotate the dial to the "11" mark and adjust potentiometer R3 for a 1.10 kHz reading on the counter.

6. Rotate the dial to provide a 100 Hz reading on the counter, and then loosen the allen screw and align the dial to the "1" mark.

7. Repeat steps 4 through 6 until the observed readings on the counter match the dial settings at 100 Hz and 1.1 kHz within ±1%, then tighten the dial allen set screws.

8. Set the FREQUENCY selector to X10 kHz, and the dial to "11", then adjust potentiometer R2 for a 110 kHz reading on the counter.

9. Check the X1 kHz and X100 kHz ranges at both ends of the dial for proper counter readings.

10. Set the FREQUENCY selector to X1 MHz and the dial to "11", then adjust trimmer C304 to obtain a 11.0 MHz ±200 kHz reading on the counter.

11. Check the frequency from 1 to 10 MHz and readjust C304 to obtain a <5% accuracy if required.

5-6. WAVESHAPE CALIBRATION.

1. Replace covers on the instrument and allow at least one hour warm up.

2. Set the FREQUENCY selector to X1 kHz and press the ∿ (sine) selector switch. Connect the OUTPUT 50Ω connector to a distortion analyzer properly terminated at 50Ω.

3. Set the dial for a 2 kHz output, adjust the AMPLITUDE and OFFSET controls for a 10V peak-to-peak sinewave with zero offset.

4. Remove the instruments top cover, and adjust potentiometer R381 for a 10V peak-to-peak triangle wave monitored at TP8 with an oscilloscope.

5. With a DVM measure the voltage at TP9 and adjust potentiometer R376 for a minimum voltage (<±50 mV). Potentiometers R381 and R376 adjustments interact so repeat steps 4 and 5 until both conditions are obtained.

6. Set up the distortion analyzer controls for measurement of minimum distortion (0.5%) and alternately adjust potentiometers R202 and R205 for minimum distortion (<1%).

7. Select ⋀⋁ (triangle) waveshape mode and a 1 kHz output frequency, set AMPLITUDE control to minimum (CCW) and monitor the OUTPUT 50Ω connector with an oscilloscope properly terminated at 50Ω.

8. Adjust the OFFSET control for a zero volt dc level.

9. Select ⎍ (square wave) mode and increase the AMPLITUDE control for a 10 volt peak-to-peak square wave.

10. Without adjusting the OFFSET control setting set in step 8, adjust potentiometer R350 to center the square wave at zero volt dc level. Then switch between ⋀⋁ and ⎍ modes and verify that the dc level remains at zero volts.

11. Select a 2 MHz square wave output and adjust trimmer capacitor C405 for best combination of fast transition times and minimum overshoot.

5-7. SWEEP CALIBRATION (MODEL 415 ONLY).

1. Configure instrument controls as follows:

CONTROL	POSITION OR SETTING
○SWEEP RATE selector range switch	100 Hz
●SWEEP RATE vernier	MAX (fully CW)

2. Set oscilloscope sweep for 2 sec/Div. and vertical sensitivity to 1 volt/Div.

3. Connect X10 probe to PCB pad BK.

4. Set SWEEP LEVEL ADJ R627 so that the peak of the ramp wave shape is at zero volts.

5.

5-8. FINAL CALIBRATION.

1. Replace covers on instrument and allow at least one-half hour warm-up.

2. Check minimum frequency on X10 kHz range. If frequency exceeds 100 Hz when FREQUENCY DIAL is set fully CW (minimum frequency), remove cover and readjust MIN FREQ ADJ R11 and SUMMETRY ADJ R15 as required.

3. Recheck paragraph 5-5 steps 5 through 11 readings and repeat adjustments if necessary.

CHAPTER 6

SCHEMATIC AND COMPONENT LOCATION DRAWINGS

6-1. INTRODUCTION

This chapter contains the schematic and component location diagrams. The schematic diagrams relate to the Principles of Operation discussions located in Chapter 4 of this manual. The parts lists contained in Chapter 7 relates to the reference designation callouts on the schematic and component location diagrams.

TABLE 6-1. LIST OF SCHEMATIC AND COMPONENT LOCATION DRAWINGS

Fig. No.	Description	S-D Dwg. #	Page No.
6-1	Main Generator Model 405/415 Schematic Diagram	113050	6-3/6-4
6-2	Sweep Circuit Model 415, Schematic Diagram	113663	6-5/6-6
6-3	Model 405/415 Power Supply Schematic Diagram	113106	6-7/6-8
6-4	Main PCB Model 405/415 Component Location Diagram	11305801	6-9/6-10
6-5	Front Panel Model 405/415 Component Location Diagram	113044	6-11/6-12
6-6	Rear Panel Model 405/415 Component Location Diagram	113055	6-13/6-14
6-7	Sweep/Rate Switch 415, Component Location Diagram	113053	6-15/6-16
6-8	Frequency Switch, Component Location Diagram	113051	6-17/6-18

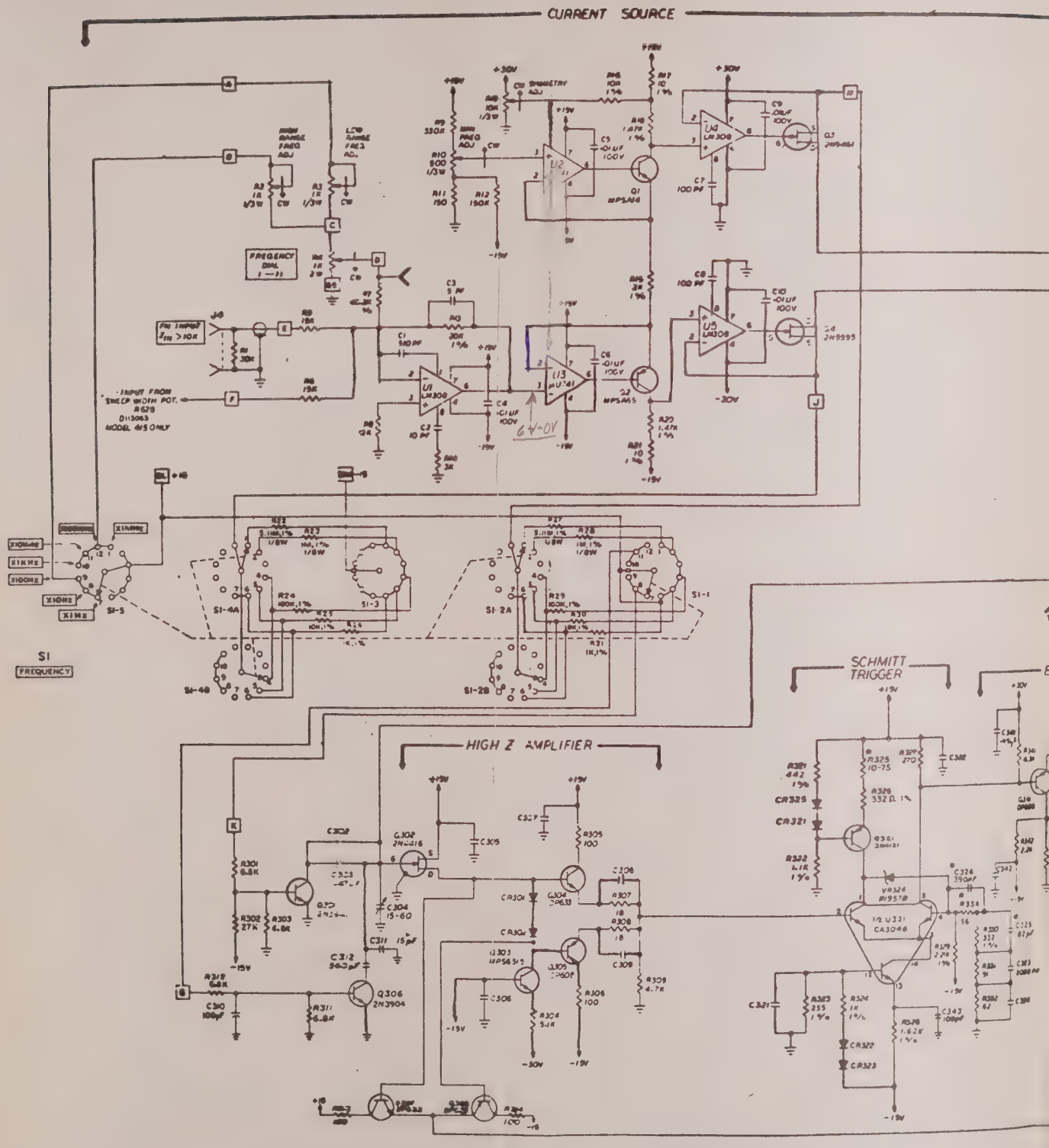
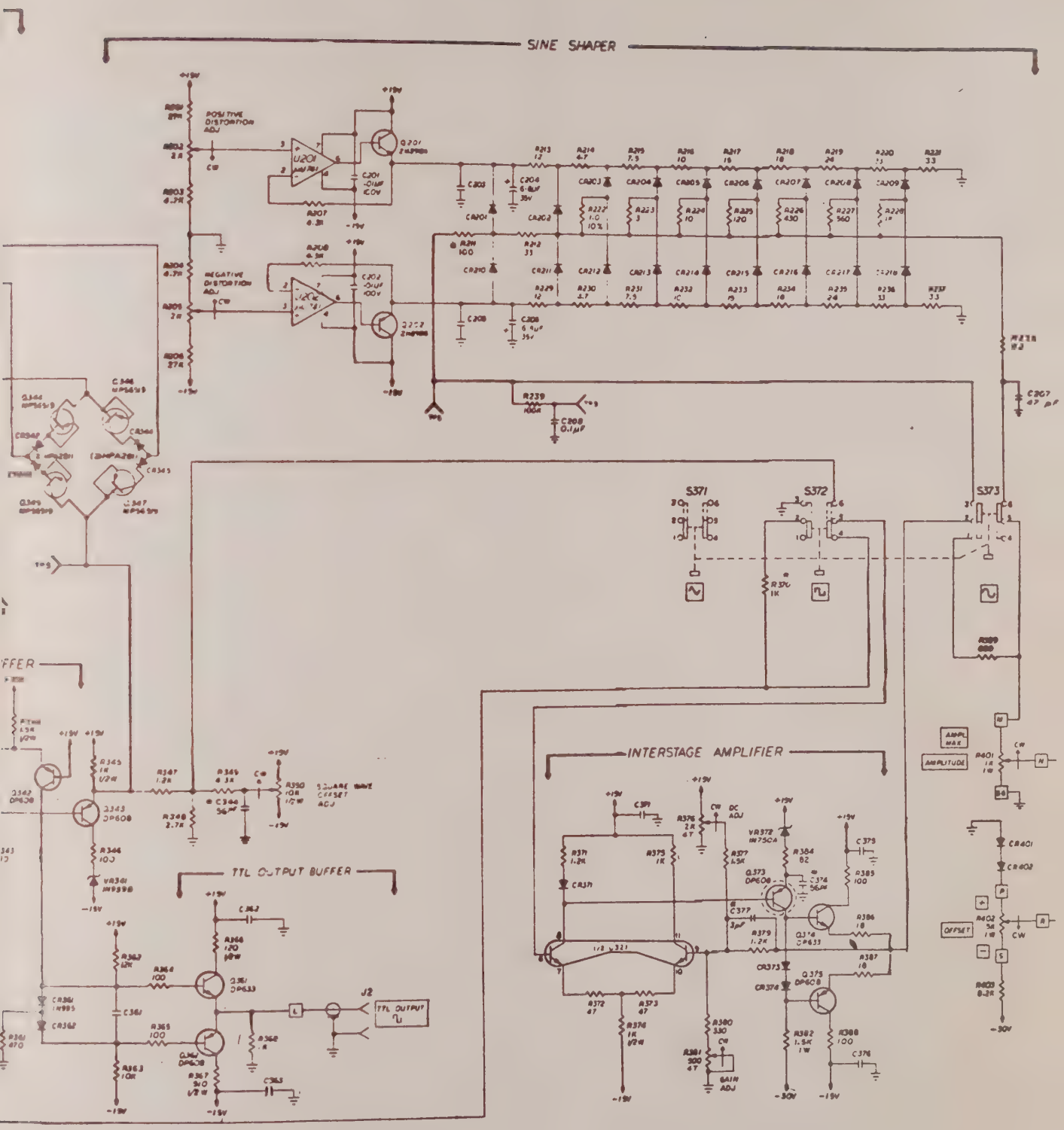


FIGURE 6-1
MAIN GENERATOR MODEL 405/475
SCHEMATIC DIAGRAM #113053


SINE SHAPER
POSITIVE DISTORTION ADJ
NEGATIVE DISTORTION ADJ
S371
S372
S373
INTERSTAGE AMPLIFIER
TTL OUTPUT BUFFER
TTL OUTPUT
AMPLITUDE
OFFSET
GAIN ADJ
DC ADJ

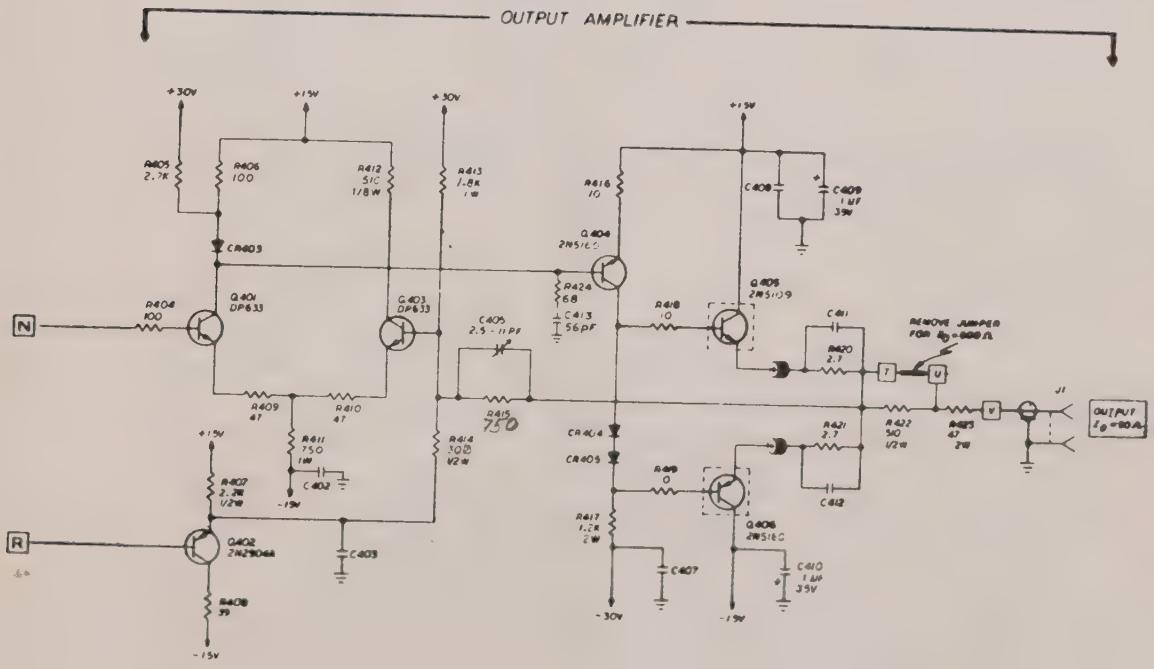
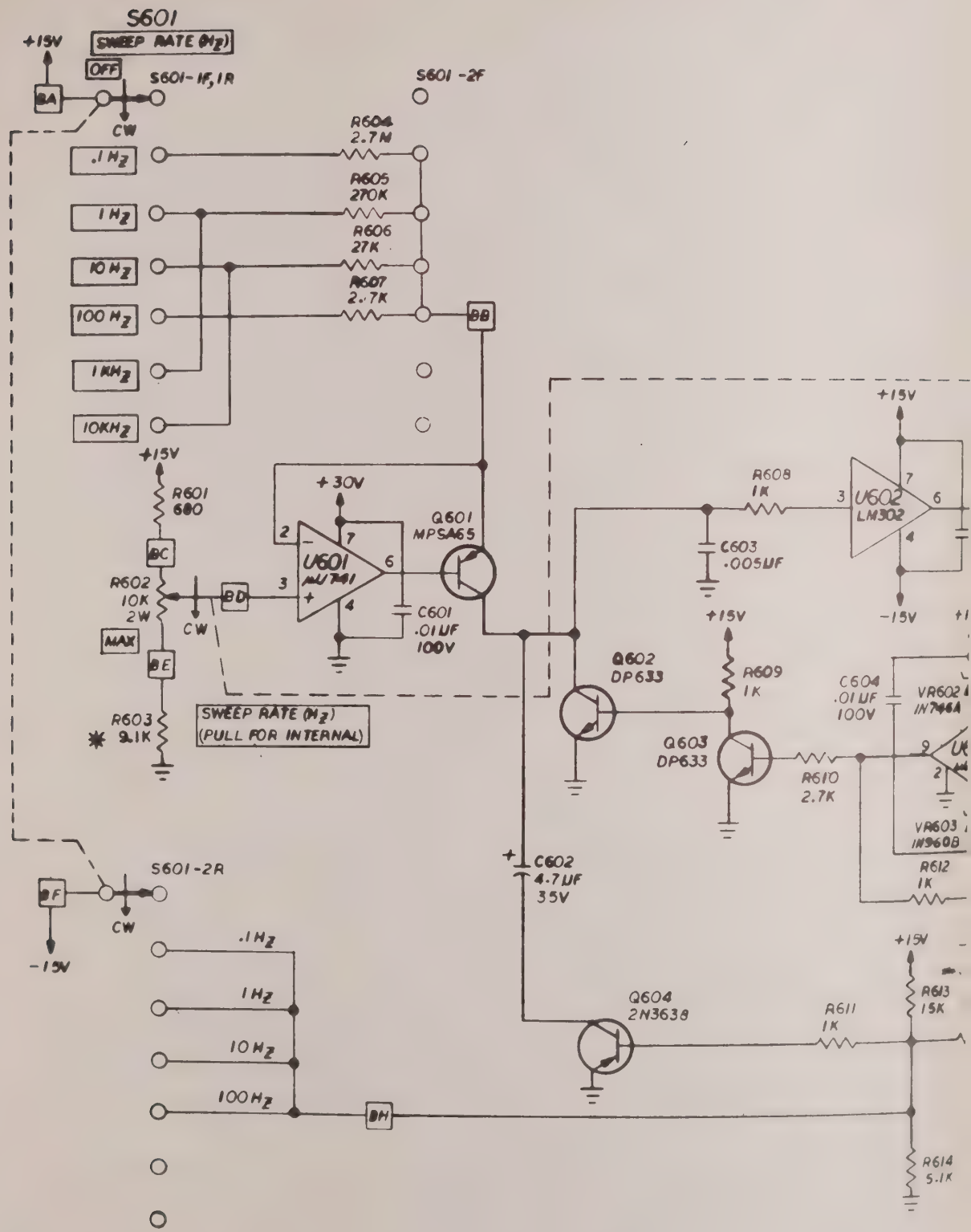


FIGURE 6-1
MAIN GENERATOR MODEL 405/415
SCHEMATIC DIAGRAM #113050


S601
SWEEP RATE (Hz)
+15V
OFF
S601-1F, 1R
S601 -2F
BA
CW
.1Hz
1Hz
10Hz
100Hz
1KHz
10KHz
R604 2.7M
R605 270K
R606 27K
R607 2.7K
BB
+15V
R601 680
BC
R602 10K 2W
MAX
BE
CW
BD
+30V
U601 MU741
Q601 MPSA65
C601 .01UF 100V
R603 2.1K
SWEEP RATE (Hz) (PULL FOR INTERNAL)
R608 1K
U602 LM302
C603 .005UF
+15V
-15V
Q602 DP633
R609 1K
Q603 DP633
C604 .01UF 100V
VR602 IN746A
R610 2.7K
VR603 IN960B
R612 1K
C602 4.7UF 35V
S601-2R
BF
CW
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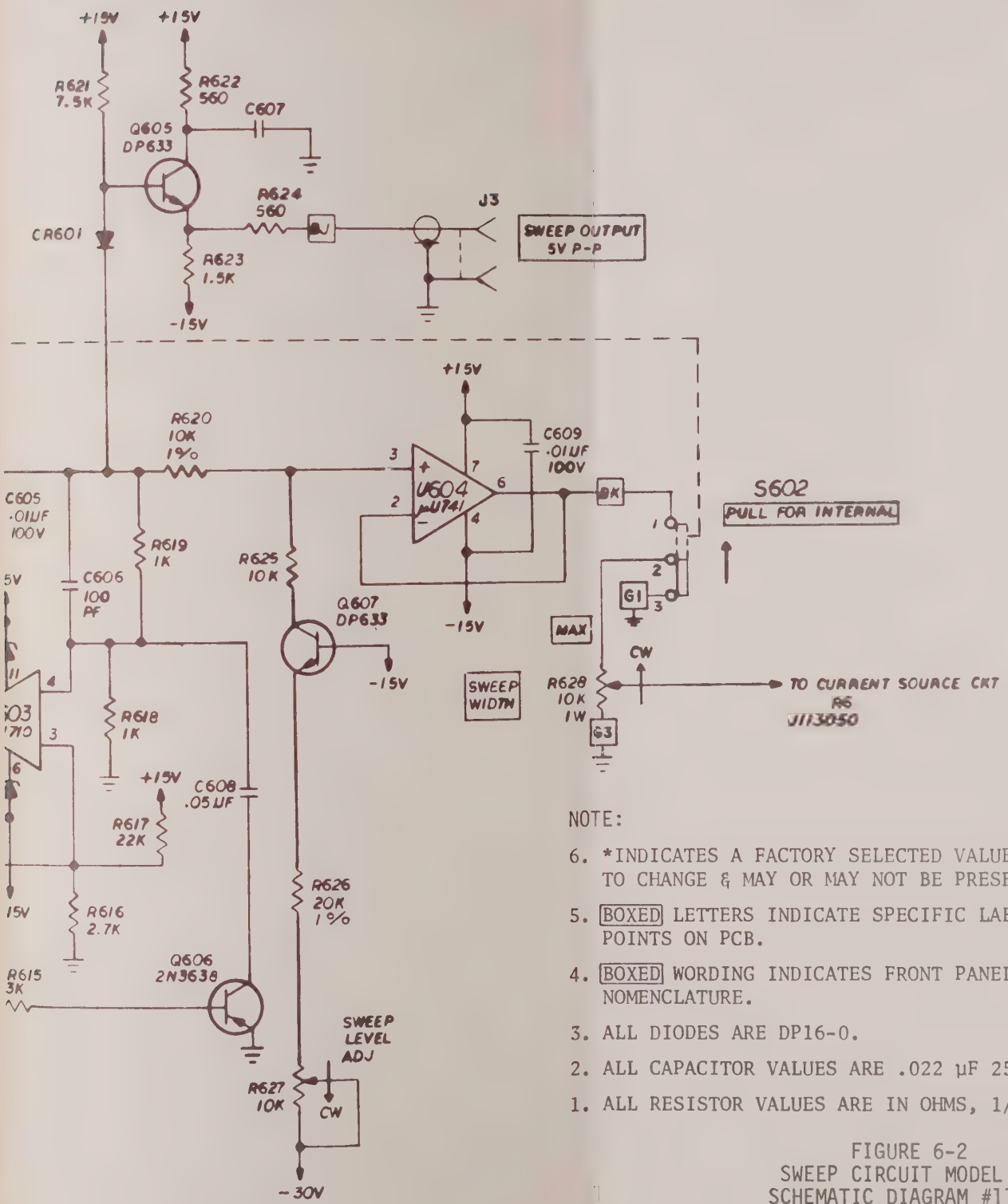
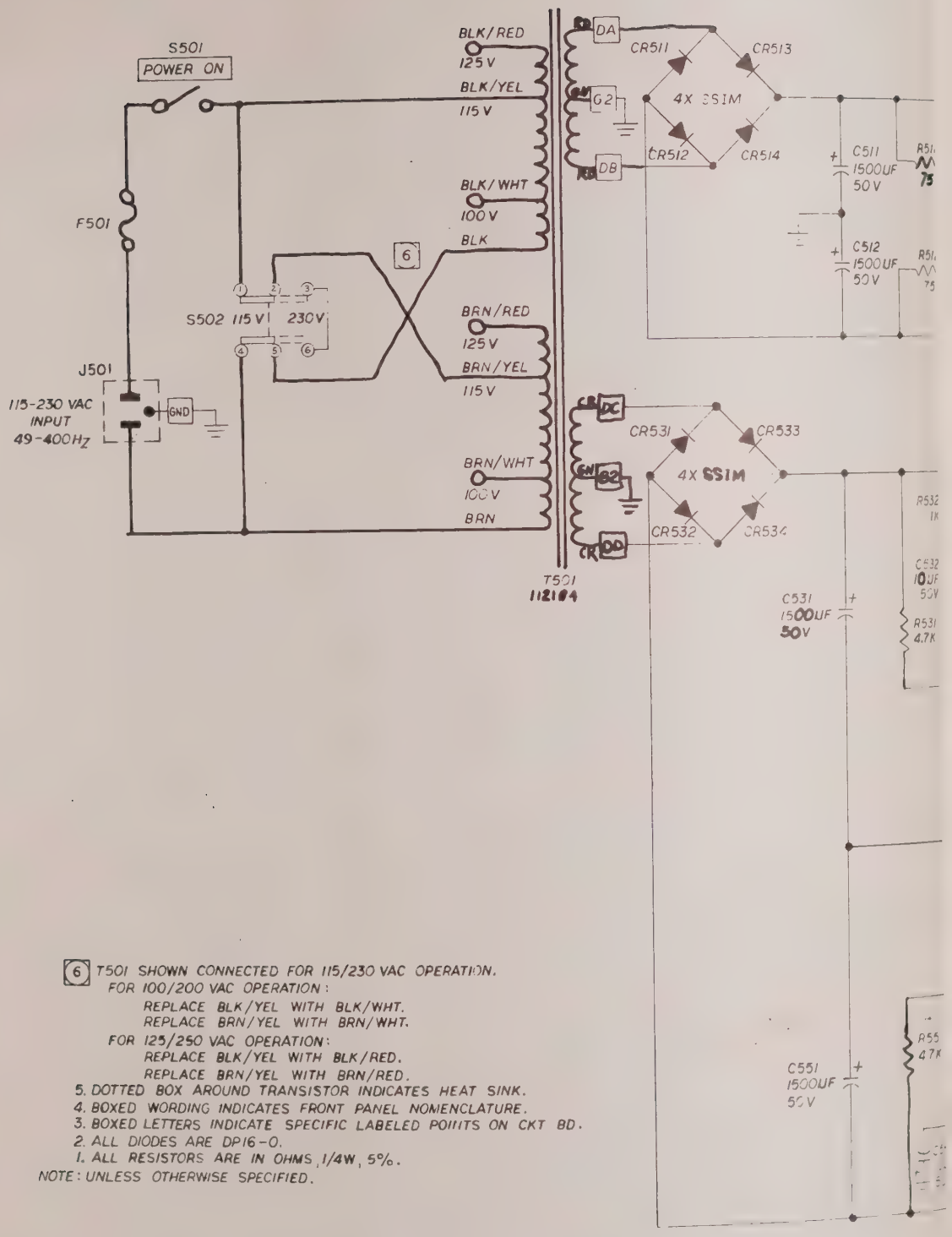
1Hz
10Hz
100Hz
BH
Q604 2N3638
R611 1K
+15V
R613 15K
R614 5.1K



NOTE:

6. *INDICATES A FACTORY SELECTED VALUE SUBJECT TO CHANGE & MAY OR MAY NOT BE PRESENT.
5. BOXED LETTERS INDICATE SPECIFIC LABELED POINTS ON PCB.
4. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
3. ALL DIODES ARE DP16-0.
2. ALL CAPACITOR VALUES ARE .022 µF 25V MIN.
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%.

FIGURE 6-2
SWEEP CIRCUIT MODEL 415
SCHEMATIC DIAGRAM #113063



6 T501 SHOWN CONNECTED FOR 115/230 VAC OPERATION.
FOR 100/200 VAC OPERATION:
REPLACE BLK/YEL WITH BLK/WHT.
REPLACE BRN/YEL WITH BRN/WHT.
FOR 125/250 VAC OPERATION:
REPLACE BLK/YEL WITH BLK/RED.
REPLACE BRN/YEL WITH BRN/RED.

5. DOTTED BOX AROUND TRANSISTOR INDICATES HEAT SINK.
4. BOXED WORDING INDICATES FRONT PANEL NOMENCLATURE.
3. BOXED LETTERS INDICATE SPECIFIC LABELED POINTS ON CKT BD.
2. ALL DIODES ARE DP16-0.
1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%.

NOTE: UNLESS OTHERWISE SPECIFIED.

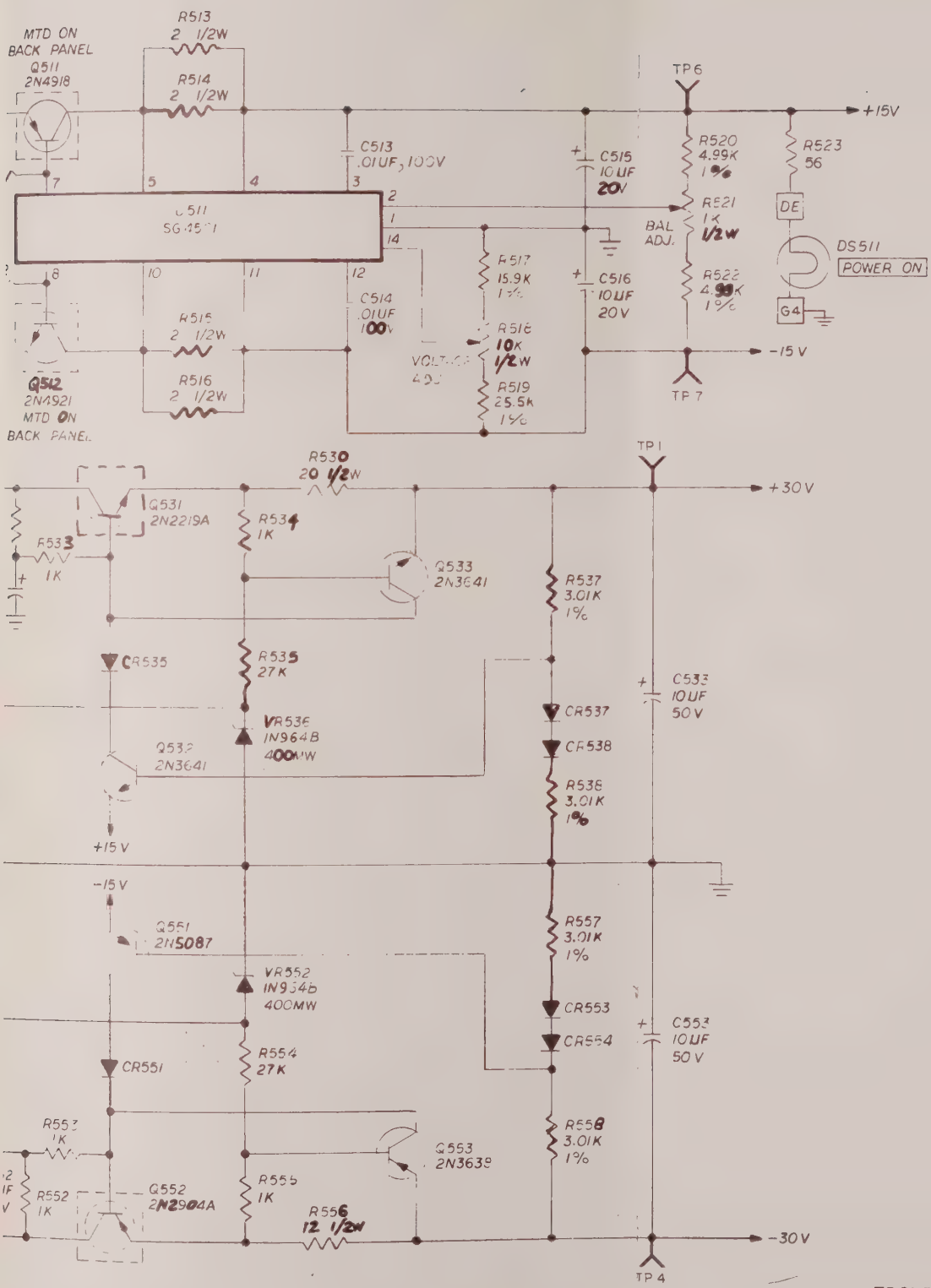


FIGURE 6-3
MODEL 405/415 POWER SUPPLY
SCHEMATIC DIAGRAM #113106

R13
C3
R7
R14
U1
C1
C2
C4
R8
R6
R5
C8
R11
U3
R12
C6
R10
R13
R9
U2
C5
Q1
R17
Q2
R21
R20
R15
U5
C10
C9
C7
R18
R16
U4
Q3
Q4
R301
Q301
Q606
C606
R612
R616
R617
VR602
R603
R311
R312
R302
R303
C310
Q305
C312
C311
C303
C304
R611
R613
R614
R615
R610
Q606
C604
Q604
R601
R603
C601
U601
CR344
CR345
R3
R2
CR343
CR342
TP3
Q344
Q346
Q345
Q347
TP5
C322
R344
R341
C341
R327
R321
CR325
C326
R326
R325
CR321
C325
R330
Q321
R331
C323
R332
C321
Q302
C305
R313
C307
R307
C308
Q304
R334
VR324
R309
C309
Q305
R308
U321
R322
R329
C321
R323
CR323
R324
CR322
R328
C343
C362
R366
R362
R364
R361
CR361
R365
CR362
C361
R363
Q361
Q362
R368
R367
C363
R389
Q342
Q341
R343
Q343
R342
R346
C342
VR341
C344
R350
R347
R349
R348
C306
R304
R306
C303
R303
R314
CR303
R214
CR202
R213
CR201
R212
R211
C204
C205
C207
R238
R239
C208
TP9
R237
R221
CR209
R228
R220
CR208
R227
CR207
R226
R218
CR206
R225
R217
CR205
R224
R216
CR204
R223
R215
CR203
R222
S373
S372
S371
R388
C376
R387
R386
Q375
Q374
CR374
CR373
C375
R382
C377
R373
R372
R380
Q373
R385
CR371
R374
R373
R384
VR372
R376
R377
R381
C374
R370
R371
R403
Q402
Q403
C371
C409
C411
C405
R415
R414
C412
R421
R419
Q405
R409
C413
R420
R423
R407
R422
JUMPER
R413
CR404
CR405
Q406

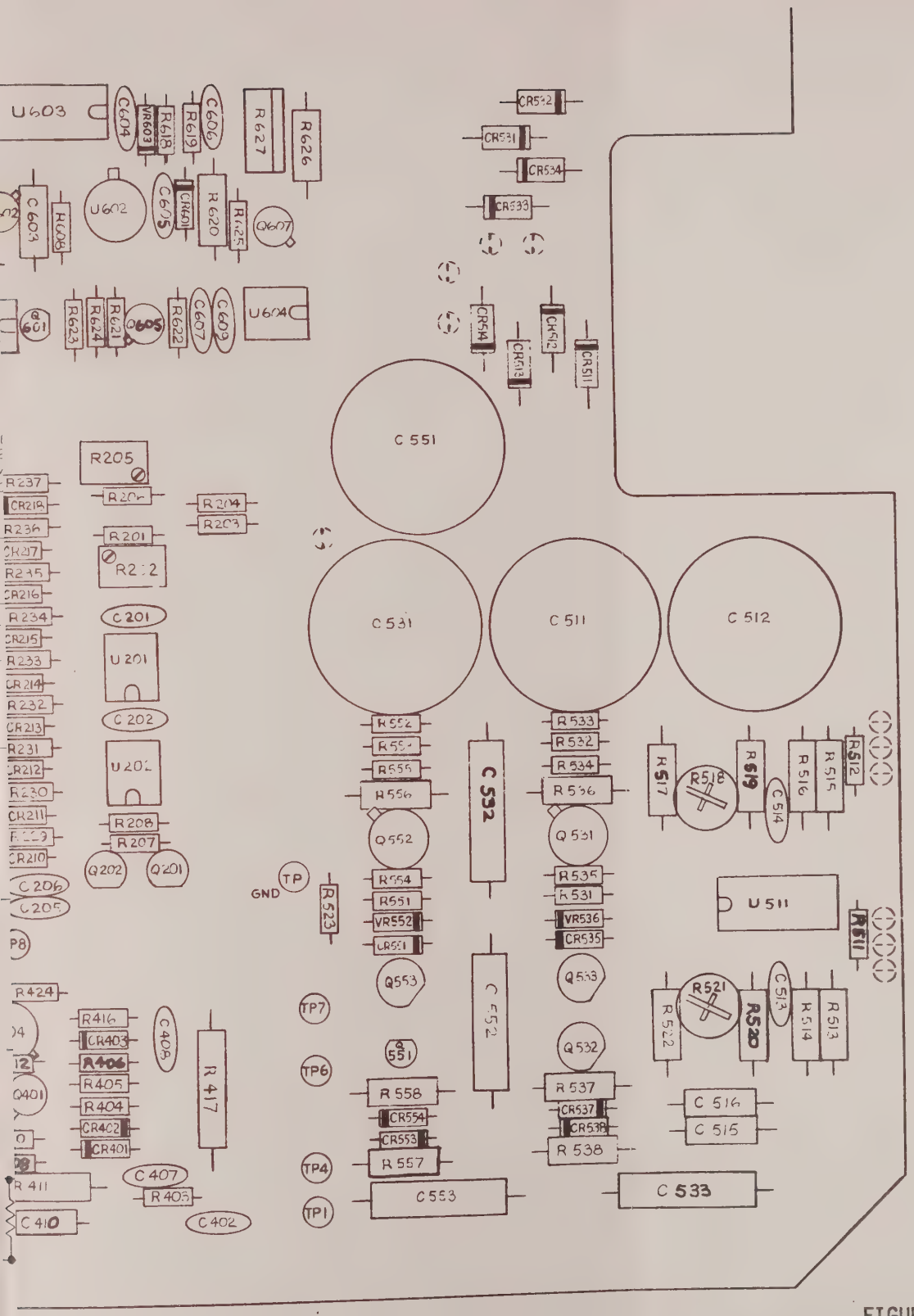
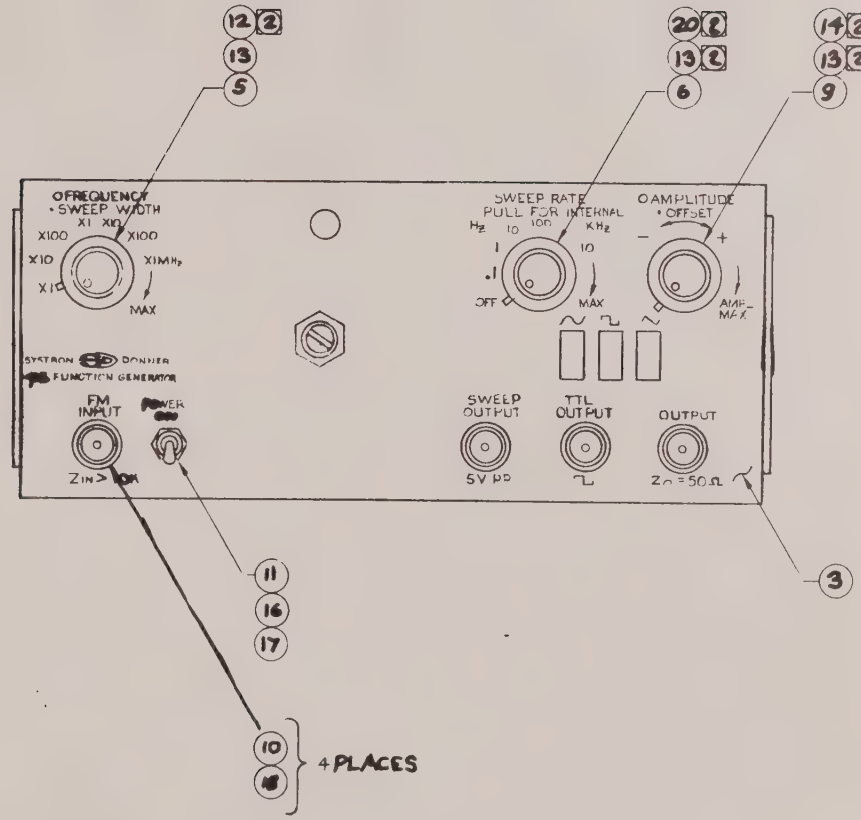
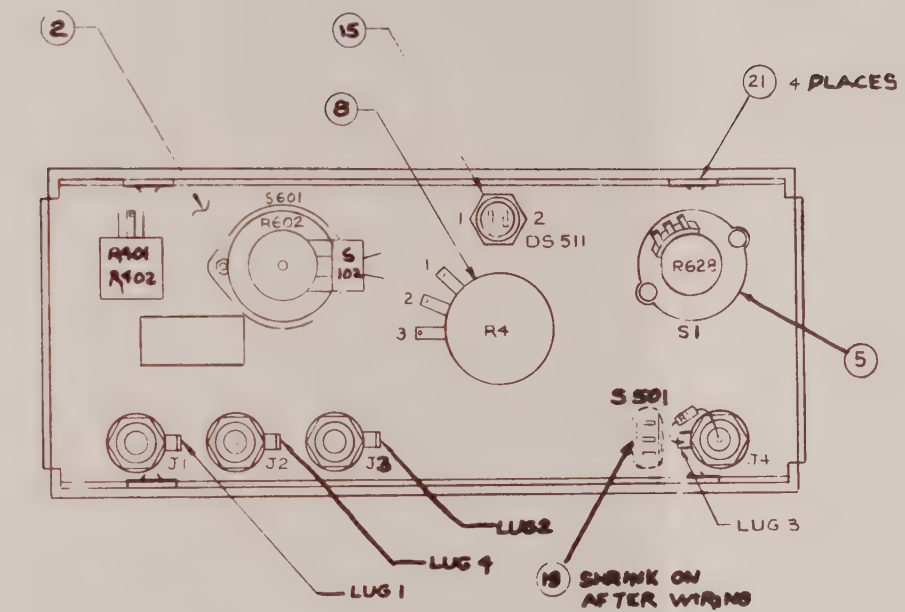
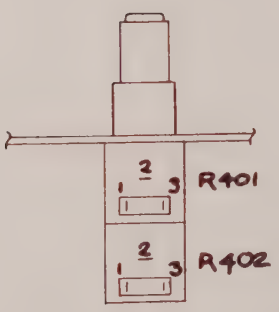
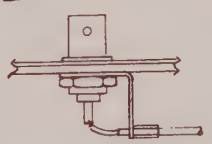


FIGURE 6-4
MAIN PCB MODEL 405/415 COMPONENT
LOCATION DIAGRAM #11305081


12 (2)
13
5
20 (2)
13 (2)
6
14 (2)
13 (2)
9
FREQUENCY
• SWEEP WIDTH
X1 X10 X100
X10 X1K
X100 X1MHz
MAX
SWEEP RATE
PULL FOR INTERNAL
Hz 10 100 KHz
1 10
.1
OFF
MAX
AMPLITUDE
• OFFSET
AMP MAX
SYSTRON DONNER
FUNCTION GENERATOR
FM INPUT
POWER
ZIN > 10K
SWEEP OUTPUT
5V pp
TTL OUTPUT
OUTPUT
ZO = 50Ω
11
16
17
3
10
4 PLACES







HOOK-UP DT'L.
TYP. J1, J2 & J3

FIGURE 6-5
FRONT PANEL MODEL 405/415 COMPONENT
LOCATION DIAGRAM #113044

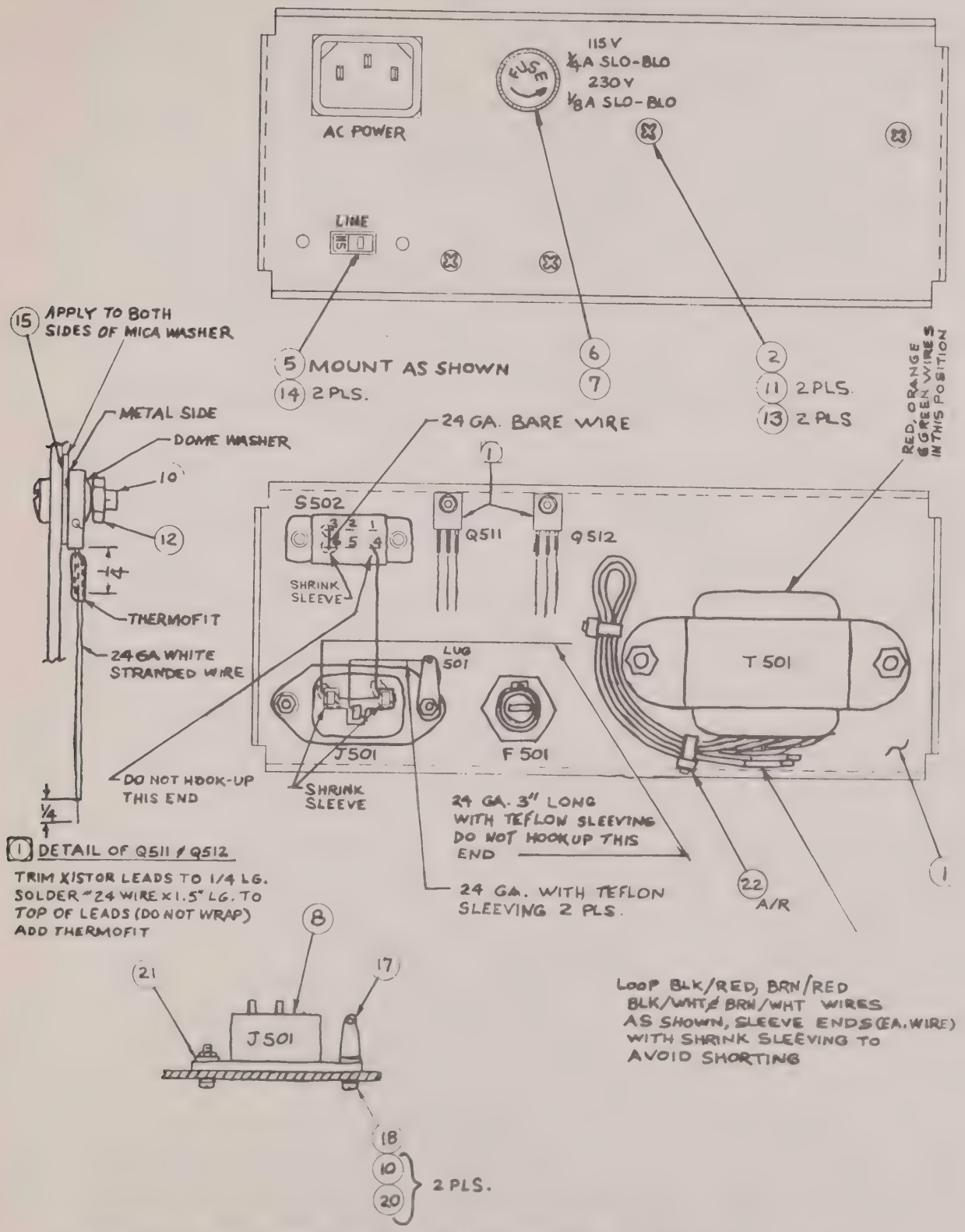
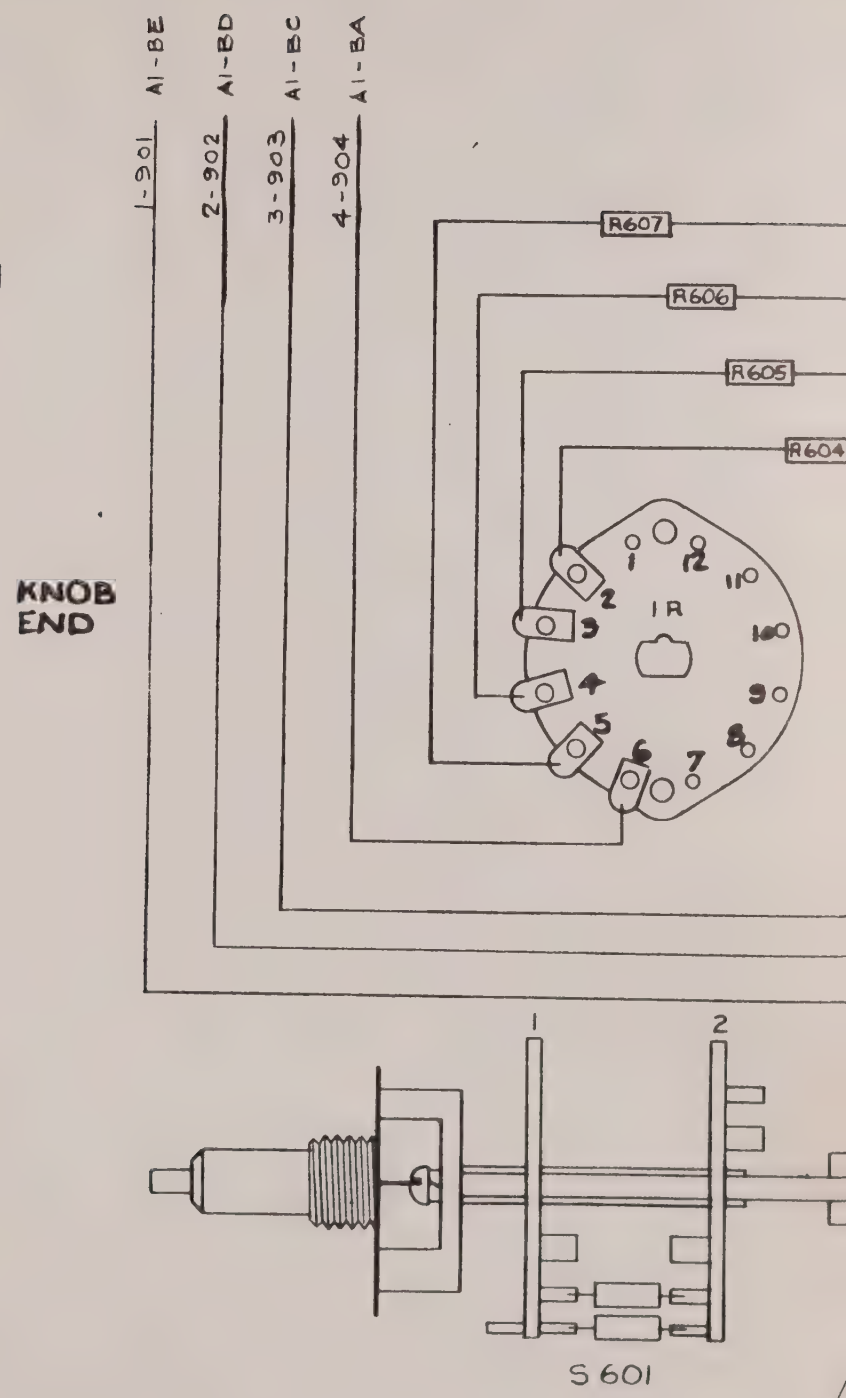


FIGURE 6-6. REAR PANEL MODEL 405/415 COMPONENT LOCATION DIAGRAM #113055


1-901 A1-BE
2-902 A1-BD
3-903 A1-BC
4-904 A1-BA
R607
R606
R605
R604
KNOB END
1R
1
2
3
4
5
6
7
8
9
10
11
12
1
2
S 601
7

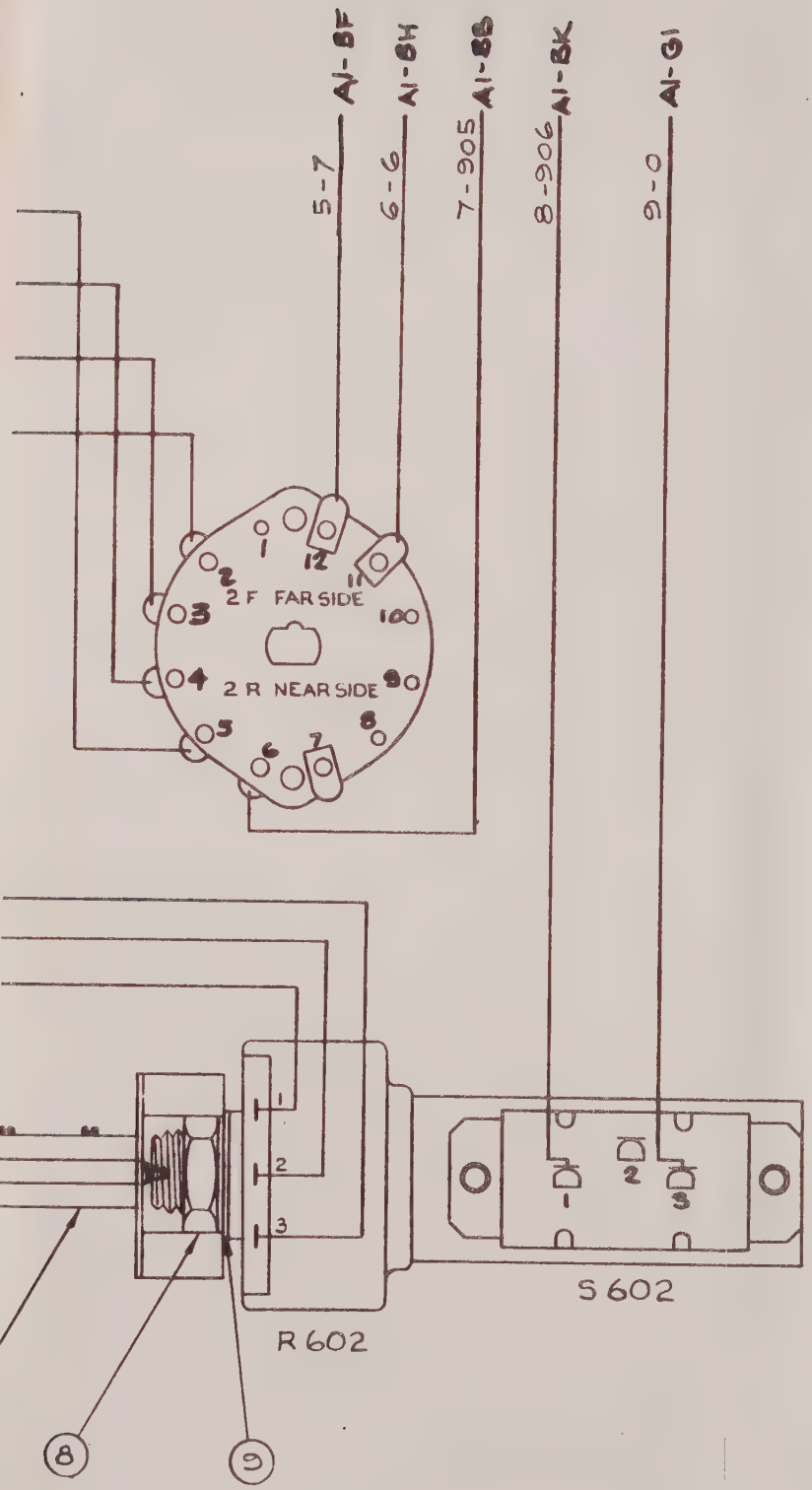
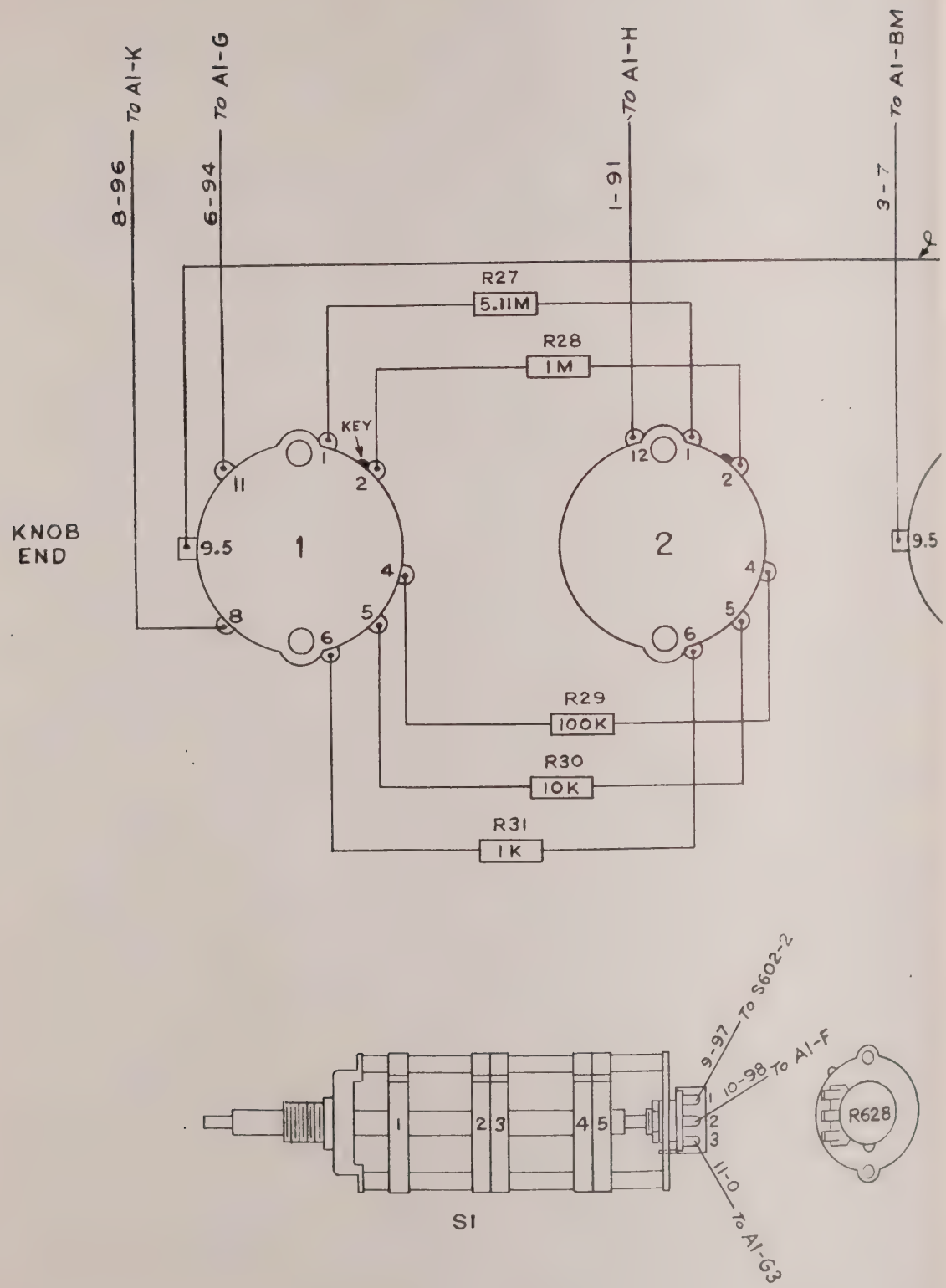


FIGURE 6-7
SWEEP/RATE SWITCH 415 COMPONENT
LOCATION DIAGRAM #113053


8-96 To A1-K
6-94 To A1-G
1-91 To A1-H
3-7 To A1-BM
R27
5.11M
R28
1M
KEY
KNOB END
9.5
1
2
R29
100K
R30
10K
R31
1K
9-97 To S602-2
10-98 To A1-F
11-0 To A1-G3
R628
S1

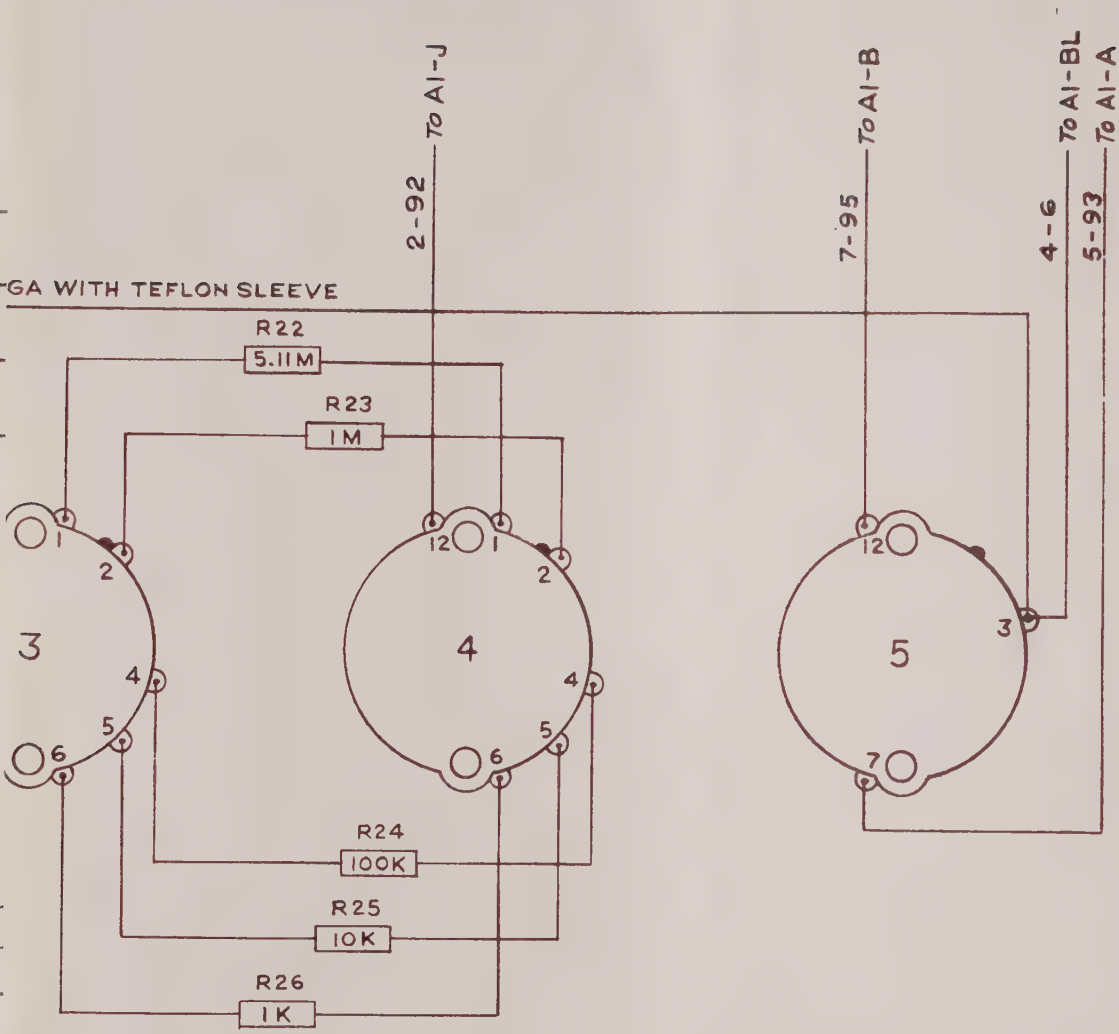


FIGURE 6-8
FREQUENCY SWITCH COMPONENT
LOCATION DIAGRAM #055466

CHAPTER 7
REPLACEABLE PARTS LIST

7-1. INTRODUCTION

This chapter provides information for ordering replaceable parts. Replaceable parts are listed in assembly order, beginning with the highest order of breakdown. Electrical parts are listed in alpha-numeric order. Part descriptions are included together with a typical manufacturer's part number, the five-digit manufacturer's identification code, Systron-Donner part number, and total quantity used. Table 7-1 contains the names and addresses that correspond to the manufacturers' code numbers.

TABLE 7-1. CODE-TO-NAME CROSS-REFERENCE

CODE	NAME	ADDRESS
7	Systron-Donner Corporation Data Products Division	935 Detroit Ave, Concord CA, 94518
01121	Allen-Bradley Co.	1201 South 2nd St., Milwaukee, WI 53204
02735	RCA Corporation Solid State Division	Route 202, Somerville, NJ 08876
03877	Transitron Electronic Corp. 168-186 Albion	168-186 Albion St., Wakefield MA 01880
04713	Motorola Semiconductor	5005 East McDowell Rd., Phoenix, AZ 85008
05820	Wakefield Engineering Inc.	Audubon Road, Wakefield, MA 01880
06811	Systron-Donner Corporation Inertial Division	1090 San Migual Rd., Concord, CA 94518
07047	Ross Milton Co. (The)	511 Second St. Pike, Southampton, PA 18966
07263	Fairchild Camera and Instrument Corp., Semiconductor Div.	313 Frontage Rd., Mountain View, CA 94040
09353	C and K Components Inc.	103 Morse, Newton, MA 02158
16299	Corning Glass Works Electric Components Div.	3900 Electronics Drive, Raleigh, NC 27604
19701	Electra/Midland Corp.	P.O. Box 760, Mineral Wells, TEX 76067
21604	Buckeye Stanping Co.	555 Marion Rd., Columbus, OH 43207
27014	National Semiconductor Corp.	2950 San Ysidro Way, Santa Clara, CA 95051

TABLE 7-1. CODE-TO-NAME CROSS-REFERENCE (CONTD)

CODE	NAME	ADDRESS
27556	IMB Electronic Prod. Inc.	15401-E Carmenita Rd., Sante Fe Springs, CA 90670
28480	Hewlett-Packard Co.	1501 Page Mill Rd., Palo Alto, CA 94304
52542	Systron-Donner Corp.	10 Systron Dr. Concord, CA 94518
56289	Sprague Electronic Co.	North Adams, Mass, 01247
71279	Cambridge Thermoinic Corp.	445 Concord Ave., Cambridge, MA 02138
71400	Bussmann Mfg. Division of McGraw-Edison Co.	2536 W. University St., St. Louis, MO 63017
71590	Globe-Union Inc. Centralab Div.	P.O. Box 591, Milwaukee, WI 53201
72136	Electro Motive Mfg. Co. Inc.	South Park & John Sts., Willimantic, CT 06226
72982	Erie Technological Products Inc.	644 W 12th St., Erie, PA 16512
74970	Johnson, E.F. Co.	299 10th Ave., S.W. Waseca, MN 56093
75042	TRW Electronic Components IRC Philadelphia Div.	401 N Broad St., Phildelphia, PA 19108
75915	Littlefuse Inc.	800 E. Nrothwest Hwy., Des Plaines, IL 60016
80294	Bourns Inc.	1200 Columbia Ave., Riverside, CA 92507
82389	Switchcraft Inc.	555 N. Elston Ave., Chicago, IL 60630
88245	Litton Precision Products Inc. USECO, Div. Litton Industries	13536 Saticoy St., Van Nuys, CA 91409
91637	Dale Electronics Inc.	P.O. Box 609, Columbus, NE 68601
99392	STM Corp.	2904 Chapman St., Oakland, CA 94601
99515	Marshall Industries Capacitor Division	1960 Walker Ave., Monrovia, CA 91016

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION: TEST ASSEMBLY #113042

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		TOKEN STD. MAIN PC ASSY	06811	11305801	11305801	1
		DIAL FREQ 415	06811	113046	113048	1
		EXTRUSION SIDE	7	03356402	03356402	2
		BRACKET BRD MTG 415	06811	113059	113059	2
		TOKEN STD. WIRE LIST	06811	113043	113043	1
	-1-	TOKEN STD. REAR PANEL ASSY	06811	113055	113055	1
	-1-	TOKEN STD. FRONT PANEL ASSY	06811	113044	113044	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION MAIN P.C. ASSEMBLY #11305801

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION		(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		PC BRD	MAIN A1 J/K	06811	113058	113058	1
	C1	CAP D MICA	510PF 500V 5%	72136	DM15FD511JO	102579	1
	C2	CAP D MICA	10PF 500V 5%	72136	DM15CD100JO	100253	1
	C3	CAP D MICA	.5PF 500V .5PF TOL	72136	DM15CD050DO	100218	1
	C4		.01UF 100V FOER DISC RAD	06811	106486	106486	13
	C5		S/A C4				
	C6		S/A C4				
	C7	CAP D MICA	100PF 500V 5%	72136	DM15FD101JO	100173	5
	C8		S/A C7				
	C9		S/A C4				
	C10		S/A C4				
	C201		S/A C4				
	C202		S/A C4				
	C203	CAP C DISC	.0220F 25V 20% .290 .25LS	71590	200D60E223M	106483	27
	C204	CAP TANT	6.8UF 35V 20% .25LS .230	56289	196D685X0035KE3	106515	2
	C205		S/A C203				
	C206		S/A C204				
	C207	CAP D MICA	47PF 500V 5%	72136	DM15ED470JO	100171	1
	C208	CAP C DISC	.1 UF 10V +80-20%	71590	UK10-104	100120	1
	C301		NOT USED				
	C302		S/A C203				
	C303	CAP METHYL	.47UF 100V 20%	99515	01-474	100061	1
	C304	CAP VARCER	15-60PF MIN. PC MT	72982	538-011F15-60	100234	1
	C305		S/A C203				
	C306		S/A C203				
	C307		S/A C203				
	C308		S/A C203				
	C309		S/A C203				
	C310		NOT USED				
	C311	CAP D MICA	150PF 500V 5%	72136	DM15CD150JO	100241	2
	C312	CAP D MICA	560PF 300V 5%	72136	DM15FC561JO	100222	1
	C321		S/A C203				
	C322		S/A C203				
	C323	CAP D MICA	2000PF 500V 5%	72136	DM19FD202JO	100117	1
	C324		S/A C203				
	C325	CAP D MICA	82PF 500V 5%	72136	DM15ED820JO	100172	1
	C326	CAP D MICA	390PF 500V 5%	72136	DM15FD391JO	100170	1
	C341		S/A C203				
	C342		S/A C203				
	C343		S/A C7				
	C344		S/A C7 FAC SEL				
	C361		S/A C203				
	C362		S/A C203				
	C363		S/A C203				
	C371		S/A C203				
	C372		S/A C311 FAC SEL				
	C373		NOT USED				
	C374	CAP D MICA	33PF 500V 5%	72136	DM15ED330JO	100175	1
	C375		S/A C203				
	C376		S/A C203				
	C377	CAP C DISC	3PF 500V .25PF TOL	72982	301-000C0J0309C	106492	1
	C401		NOT USED				
	C402		S/A C203				
	C403		S/A C203				
	C404		NOT USED				
	C405	CAP VARCER	2.5-11PF 200V	72982	536-014-908	106499	1
	C406		NOT USED				
	C407		S/A C203				
	C408		S/A C203				
	C409	CAP TANT	1 UF 35V 10%	56289	150D105X9035A2	100082	2

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION: MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	C410	S/A C409				
	C411	S/A C203				
	C412	S/A C203				
	C413	CAP C MICA 56PF 500V 5%	72136	DM15ED560J0	100179	1
	C511	CAP EL CAN 1500UF 50V PC MT 1*1.75L	99392	23C5015152	106468	4
	C512	S/A C511				
	C513	S/A C4				
	C514	S/A C4				
	C515	CAP TANT 10UF 20V 10%	56289	150D106X9020B2	100063	2
	C516	S/A C515				
	C531	S/A C511				
	C532	CAP EL AX 100F 50V 5/16X11/16L	56289	TE1304	106445	4
	C533	S/A C532				
	C551	S/A C511				
	C552	S/A C532				
	C555	S/A C532				
	C601	S/A C4				
	C602	4.7UF 35V 10 TAN AX	06611	106529	106529	1
	C603	CAP METAYL 0.005UF 200V 2%	27556	8A2C5020	106477	1
	C604	S/A C4				
	C605	S/A C4				
	C606	S/A C7				
	C607	S/A C203				
	C608	CAP C DISC .05UF 25V	72982	5855Y5U503Z	106484	1
	C609	S/A C4				
	CR201	DP1G 0 40V AX SIL	06611	112127	112127	40
	CR202	S/A CR201				
	CR203	S/A CR201				
	CR204	S/A CR201				
	CR205	S/A CR201				
	CR206	S/A CR201				
	CR207	S/A CR201				
	CR208	S/A CR201				
	CR209	S/A CR201				
	CR210	S/A CR201				
	CR211	S/A CR201				
	CR212	S/A CR201				
	CR213	S/A CR201				
	CR214	S/A CR201				
	CR215	S/A CR201				
	CR216	S/A CR201				
	CR217	S/A CR201				
	CR218	S/A CR201				
	CR301	S/A CR201				
	CR302	S/A CR201				
	CR321	S/A CR201				
	CR322	S/A CR201				
	CR323	S/A CR201				
	CR324	NOT USED				
	CR325	S/A CR201				
	CR341	NOT USED				
	CR342	DIODE SGNL 15V 100PS 1.2PF .41V@1MA	28480	5082-2811	106557	4
	CR343	S/A CR342				
	CR344	S/A CR342				
	CR345	S/A CR342				
	CR361	DIODE SGNL 1N995 GERM 15PIV .5V@.01A	06611	1N995	106548	1
	CR362	S/A CR201				
	CR371	S/A CR201				
	CR372	NOT USED				
	CR373	S/A CR201				
	CR374	S/A CR201				

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION		(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	CR401		S/A CR201				
	CR402		S/A CR201				
	CR403		S/A CR201				
	CR404		S/A CR201				
	CR405		S/A CR201				
	CR511	DIODE RECT	1N4005 600V 1A	04713	1N4005	100413	8
	CR512		S/A CR511				
	CR513		S/A CR511				
	CR531		S/A CR511				
	CR532		S/A CR511				
	CR533		S/A CR511				
	CR534		S/A CR511				
	CR535		S/A CR201				
	CR536		NOT USED				
	CR537		S/A CR201				
	CR538		S/A CR201				
	CR551		S/A CR201				
	CR552		NOT USED				
	CR553		S/A CR201				
	CR554		S/A CR201				
	CR601		S/A CR201				
	Q1		MPSA14 DT 30V NPN DARPR	06811	106616	106616	1
	Q2	XSTR SIPNP	MPS-A65 DARLINGTON	04713	MPS-A65	101404	2
	Q3	JFET PCHNL	2N5461	04713	2N5461	101383	1
	Q4		2N5555 JUNC FET H CH SIL	06811	106612	106612	1
	Q201	XSTR SINPN	2N3904	04713	2N3904	101377	1
	Q202	XSTR SIPNP	2N3906	04713	2N3906	101378	1
	Q301		2N3641 250MC .5A NPN SIL	06811	106586	106586	4
	Q302		2N4416 JUNC FET N CH SIL	06811	106613	106613	1
	Q303		MPS6515 AMP NPN SIL	06811	106593	106593	1
	Q304		DP633 H SP SW NPN SIL	06811	112150	112150	10
	Q305		TRANSISTER DP608	06811	112148	112148	8
	Q306		S/A Q301				
	Q307		S/A Q304				
	Q308		S/A Q305				
	Q321	XSTR SIPNP	2N4121	07263	2N4121	102713	1
	Q341		S/A Q305				
	Q342		S/A Q305				
	Q343		S/A Q305				
	Q344		MPS6519 AMP PNP SIL	06811	106578	106578	4
	Q345		S/A Q344				
	Q346		S/A Q344				
	Q347		S/A Q344				
	Q361		S/A Q304				
	Q362		S/A Q305				
	Q373		S/A Q305				
	Q374		S/A Q304				
	Q375		S/A Q305				
	Q401		S/A Q304				
	Q402	XSTR SIPNP	2N2904A 60V BGT40 3W TO-5	04713	2N2904A	106572	2
	Q403		S/A Q304				
	Q404		2N5109 RF PWR PNP SIL	06811	106576	106576	2
	Q405		ISTR 2N5109	06811	106591	106591	1
	Q406		S/A Q404				
	Q511		SEE113055				
	Q512		SEE113055				
	Q531	XSTR SIPNP	2N2219A W/HEAVY KOVAR HDR	07263	2N2219A SF HDR	106587	1

EQUIPMENT/ASSEMBLY DESIGNATION: MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	Q532	S/A Q301				
	Q533	S/A Q301				
	Q551	2N5087 SM SIG AMP PNP SI	06811	106575	106575	1
	Q552	S/A Q402				
	Q553	XSTR SIPNP 2N3638	07263	2N3638	101360	3
	Q601	S/A Q2				
	Q602	S/A Q304				
	Q603	S/A Q304				
	Q604	S/A Q553				
	Q605	S/A Q304				
	Q606	S/A Q553				
	Q607	S/A Q304				
	R1	SEE113044				
	R2	POT 1T PC 1K 20% 1/3W CERM SUBS	80294	3353W-1-102	106068	2
	R3	S/A R2				
	R4	SEE113044				
	R5	RES CC1/4W 15K 5%	01121	CB1535	101552	3
	R6	S/A R5				
	R7	40.2K 1/4W FMF RN60D	06811	106322	106322	1
	R8	RES CC1/4W 12K 5%	01121	CB1235	101565	2
	R9	RES CC1/4W 330K 5%	01121	CB3345	101658	1
	R10	POT 1T PC 500 20% 1/3W CERM SUBS	80294	3353W-1-501	106071	1
	R11	RES CC1/4W 150 OHMS 5%	01121	CB1515	101615	1
	R12	RES CC1/4W 150K 5%	01121	CB1545	101604	1
	R13	RES MF 20.0K .12W 1% 100PPM	06811	RN60D2002F	106315	2
	R14	RES CC1/4W 3.0K 5%	01121	CB3025	101548	2
	R15	POT 1T PC 10K 20% 1/3W CERM SUBS	80294	3353W-1-103	106069	2
	R16	RES MF 10.0K .12W 1% 50PPM	06811	RN60C1002F	106162	2
	R17	RES MF 10 1% .12W 100PPM	16299	NA60	106210	2
	R18	RES MF 1.47K .12W 1% 50PPM	06811	RN60C1471F	106167	2
	R19	RES MF 2.00K .12W 1% 100PPM	16299	NA60	106224	1
	R20	S/A R18				
	R21	S/A R1M				
	R201	RES CC1/4W 27K 5%	01121	CB2735	101587	4
	R202	POT 1T PC 2K 20% 1/2W CERM TOPADJ	80294	3339H-1-202	102300	3
	R203	RES CC1/4W 4.7K 5%	01121	CB4725	101598	5
	R204	S/A R203				
	R205	S/A R202				
	R206	S/A R201				
	R207	RES CC1/4W 4.3K 5%	01121	CB4325	101546	4
	R208	S/A R207				
	R211	75-110 1/4W5% FAC SEL				
	R212	RES CC1/4W 33 OHMS 5%	01121	CB3305	101731	5
	R213	RES CC1/4W 12 OHMS 5%	01121	CB1205	101756	2
	R214	RES CC1/4W 4.7 OHMS 5%	01121	CB4705	101796	2
	R215	RES CC1/4W 7.5 OHMS 5%	01121	CB75G5	101687	2
	R216	RES CC1/4W 10 OHMS 5%	01121	CB1005	101557	6
	R217	RES CC1/4W 15 OHMS 5%	01121	CB1505	101764	2
	R218	RES CC1/4W 18 OHMS 5%	01121	CB1805	101727	7
	R219	RES CC1/4W 24 OHMS 5%	01121	CB2405	101728	2
	R220	S/A R212				
	R221	S/A R212				
	R222	1 1/4 10 FC AA	06811	112284	112284	1
	R223	RES CC1/4W 3.0 OHMS 5%	01121	CB3G05	101765	1
	R224	S/A R216				
	R225	RES CC1/4W 120 OHMS 5%	01121	CB1215	101717	1
	R226	RES CC1/4W 430 OHMS 5%	01121	CB4315	101774	1
	R227	RES CC1/4W 560 OHMS 5%	01121	CB5615	101583	3
	R228	RES CC1/4W 1 K 5%	01121	CB1025	101569	15
	R229	S/A R213				

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	R230	S/A R214				
	R231	S/A R215				
	R232	S/A R216				
	R233	S/A R217				
	R234	S/A R218				
	R235	S/A R219				
	R236	S/A R212				
	R237	S/A R212				
	R238	RES CC1/4W 82 OHMS 5%	01121	CB8205	101629	1
	R239	RES CC1/4W 100K 5%	01121	CB1045	101558	1
	R301	RES CC1/4W 10K 5%	01121	CB1035	101570	2
	R302	NOT USED				
	R303	RES CC1/4W 6.8K 5%	01121	CB6825	101544	2
	R304	RES CC1/4W 5.1K 5%	01121	CB5125	101541	2
	R305	RES CC1/4W 100 OHMS 5%	01121	CB1015	101609	11
	R306	S/A R305				
	R307	S/A R218				
	R308	S/A R218				
	R309	S/A R203				
	R310	NOT USED				
	R311	S/A R303				
	R312	S/A R301				
	R313	S/A R305				
	R314	S/A R305				
	R321	RES MF 442 .12W 1% 100PPM	91637	MFF-1/8 T1	102228	1
	R322				106213	1
	R323	RES MF 255 .12W 1% 100PPM	19701	MF5C-0-2550F	102135	1
	R324	1K 1/4W 1 FMF KN60D	06611	106310	106310	1
	R325					
	R326	332 1/4W 1 FMF CG NA60	06611	106239	106239	2
	R327	RES CC1/4W 270 OHMS 5%	01121	CB2715	101542	1
	R328	RES MF 1.62K .12W 1% 100PPM	91637	MFF-1/8 T1	102195	1
	R329	RES MF 2.21K .12W 1% 100PPM	16299	NA60	106226	1
	R330	S/A R326				
	R331	RES CC1/4W 91 OHMS 5%	01121	CB9105	101663	1
	R332	RES CC1/4W 62 OHMS 5%	01121	CB6205	101736	1
	R333	NOT USED				
	R334	RES CC1/4W 56 OHMS 5%	01121	CB5605	101735	1
	R341	S/A R207				
	R342	RES CC1/4W 2.2K 5%	01121	CB2225	101562	1
	R343	RES CC1/4W 510 OHMS 5%	01121	CB5115	101616	1
	R344	RES CC1/2W 1.5K 5%	01121	EB1525	101459	1
	R345	RES CC1/2W 1 K 5%	01121	EB1025	101467	2
	R346	S/A R305				
	R347	RES CC1/4W 1.2K 5%	01121	CB1225	101581	3
	R348	RES CC1/4W 2.7K 5%	01121	CB2725	101599	4
	R349	S/A R207				
	R350	POT 11 PC 10K 20% 1/2W CERM TOPADJ	06611	918	106104	1
	R361	RES CC1/4W 470 OHMS 5%	01121	CB4715	101625	2
	R362	S/A R8				
	R363	RES CC1/4W 10K 5%	01121	CB1035	101570	2
	R364	S/A R305				
	R365	S/A R305				
	R366	RES CC1/2W 120 OHMS 5%	01121	EB1215	101508	1
	R367	RES CC1/2W 510 OHMS 5%	01121	EB5115	101767	2
	R368	S/A R228				
	R369	NOT USED				
	R370	S/A R361				
	R371	S/A R347				
	R372	RES CC1/4W 47 OHMS 5%	01121	CB4705	101560	4
	R373	S/A R372				
	R374	S/A R345				

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	R375	S/A R228				
	R376	S/A R202				
	R377	RES CC1/4W 1.5K 5%	01121	CB1525	101577	2
	R378	NOT USED				
	R379	S/A R347				
	R380	RES CC1/4W 330 OHMS 5%	01121	CB3315	101536	1
	R381	POT 4T PC 500 20% 1/2W CERM TOPADJ	80294	3339H-1-501	102163	1
	R382	RES CC 1W 1.5K 5%	01121	GB1525	101841	1
	R383	NOT USED				
	R384	S/A R218				
	R385	S/A R305				
	R386	S/A R218				
	R387	S/A R218				
	R388	S/A R305				
	R389	RES CC1/4W 680 OHMS 5%	01121	CB6815	101669	2
	R401	SEE113044				
	R402	SEE113044				
	R403	RES CC1/4W 6.2K 5%	01121	CB6225	101595	2
	R404	S/A R305				
	R405	S/A R340				
	R406	S/A R305				
	R407	RES CC1/2W 2.2K 5%	01121	EB2225	101454	1
	R408	RES CC1/4W 39 OHMS 5%	01121	CB3905	101733	1
	R409	S/A R372				
	R410	S/A R372				
	R411	RES CC 1W 750 OHMS 5%	01121	GB7515	101857	1
	R412	RES CC1/8W 510 OHMS 5%	01121	BB5115	101804	1
	R413	RES CC 1W 1.8K 5%	01121	GB1825	101867	1
	R414	RES CC1/2W 300 OHMS 5%	01121	EB3015	101448	1
	R415	RES CC1/4W 750 OHMS 5%	01121	CB7515	101689	1
	R416	S/A R216				
	R417	RES CC 2W 1.2K 5%	01121	HB1225	106036	1
	R418	S/A R216				
	R419	S/A R216				
	R420	RES CC1/4W 2.7 OHMS 5%	01121	CB2705	101784	2
	R421	S/A R420				
	R422	S/A R367				
	R423	RES CC 2W 47 OHMS 5%	01121	HB4705	101780	1
	R424	RES CC1/4W 68 OHMS 5%	01121	CB6805	101690	1
	R511	RES CC1/4W 75 OHMS 5%	01121	CB7505	101737	2
	R512	S/A R511				
	R513	RES CC1/2W 2.0 OHMS 5%	01121	EB2005	106010	4
	R514	S/A R513				
	R515	S/A R513				
	R516	S/A R513				
	R517	RES MF 15.9K .12W 1% 100PPM	06011	RN60D1592F	106313	1
	R518	POT 1T PC 10K 20% 1/2W CERM TOPADJ	06011	918	106104	1
	R519	RES MF 25.5K .12W 1% 50PPM	06011	RN60C2552F	106176	1
	R520	RES MF 4.99K .12W 1% 100PPM	91637	MFF 1/8 T1	102079	2
	R521	POT 1T PC 1K 20% 1/2W CERM TOPADJ	06011	918	106103	1
	R522	S/A R520				
	R523	RES CC1/4W 56 OHMS 5%	01121	CB5605	101735	1
	R531	S/A R203				
	R532	S/A R226				
	R533	S/A R228				
	R534	S/A R228				
	R535	S/A R201				

EQUIPMENT/ASSEMBLY DESIGNATION: MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	R536	RES CC1/2W 20 OHMS 5%	01121	EB2005	106009	1
	R537	3.01K 1/4W 1 FMF RN60D	06811	106317	106217	1
	R538	S/A R537				
	R551	S/A R203				
	R552	S/A R228				
	R553	S/A R228				
	R554	S/A R101				
	R555	S/A R228				
	R556	RES CC1/2W 12 OHMS 5%	01121	EB1205	106005	1
	R557	S/A R537				
	R558	S/A R537				
	R601	S/A R389				
	R602	SEE113053				
	R603	S/A R403				
	R604	SEE113053				
	R605	SEE113053				
	R606	SEE113053				
	R607	SEE113053				
	R608	S/A R228				
	R609	S/A R228				
	R610	S/A R348				
	R611	S/A R228				
	R612	S/A R228				
	R613	S/A R5				
	R614	S/A R304				
	R615	S/A R14				
	R616	S/A R348				
	R617	RES CC1/4W 22K 5%	01121	CB2235	101572	1
	R618	S/A R228				
	R619	S/A R228				
	R620	S/A R16				
	R621	RES CC1/4W 7.5K 5%	01121	CB7525	101596	1
	R622	S/A R227				
	R623	S/A R377				
	R624	S/A R227				
	R625	S/A R363				
	R626	S/A R13				
	R627	S/A R15				
	R628	SEE113053				
	S371	SW PUSH ITLK 3 BANK	06811	106627	106827	1
	S372	P/O S371				
	S373	P/O S371				
	TP	GND	74970	105-0853-001	100542	1
	TP	1	74970	105-0858-001	100546	1
	TP	2				
	TP	3	74970	105-0856-001	100544	1
	TP	4	74970	105-0857-001	100545	1
	TP	5	74970	105-0854-001	100543	1
	TP	6	74970	105-0860-001	100547	1
	TP	7	74970	105-0862-001	100548	1
	TP	8	74970	105-0863-001	100549	1
	TP	9	71279	3623-5	100550	1
	U1	LIN OP AMP H PERF LM308N	06811	106627	106627	3
	U2	IC OP AMP 741C A8608 IB.5VA 8DIP	07263	741TC	106621	6
	U3	S/A U2				
	U4	S/A U1				
	U5	S/A U1				
	U201	S/A U2				
	U202	S/A U2				
	U321	IC LIN 4SC CA3046 NPN 3XSTR+DIFF PR	02735	CA3046	025725	1
	U511	DUAL 15V REG SG+501	06811	106626	106626	1
	U601	S/A U2				

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION MAIN P.C. ASSEMBLY #11305801 (CONTD)

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	U602	IC LIN AMP LM302 VOLT FOLLOWER	27014	LM302H	026721	1
	U603	LIN H SP DIF COMPUA710C	06811	106622	106622	1
	U604	S/A U2				
	VR324	DIODE ZENR 6.8V 5% .4W 1N957B	04713	1N957B	100416	1
	VR341	DIODE ZENR 6.2V 5% .4W 1N959B	04713	1N959B	100429	1
	VR372	1N750A 4.7V 400MW 5 AX	06811	112135	112135	1
	VR536	DIODE ZENR 13V 5% .4W 1N964B	04713	1N964B	100412	2
	VR552	S/A VR536				
	VR602	DIODE ZENR 3.3V 5% .4W 1N746A	03877	1N746A	100415	1
	VR603	DIODE ZENR 9.1V 5% .4W 1N960B	04713	1N960B	100430	1
		SHLD BEAD .138D .047ID .059L 4A MAT	52542	112420	112420	2
		XSTR MT PD .340 .1HI 3LD GN.1R	07047	A-10029	112279	13
		HEAT SINK TO 8 NF 203	06811	106951	106951	1
		HEATSINK TO-5 .72D .38H 45C/W	05820	207CB	100746	3
		HEATSINK TO-5 1.26D .44H 30C/W	05820	209CB	100497	1
		TERM SWAGE BIFUR .062MAT.16HI.065MTG	88245	20008	100482	11

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION REAR PANEL ASSEMBLY (405) #115056901

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		PANEL REAR 405	06811	113056	113056	1
		SW SLIDE DPDT 115-230 SD 1.125 MTG	82389	46206LFR	102340	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION REAR PANEL ASSEMBLY #113055

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		XFMR PWR 400/411	06811	112184	112184	1
		XSTR SI PNP 2N4918 30W	04713	2N4918	101387	1
		XSTR SI NPN 2N4921 30W	04713	2N4921	101386	1
		FUSE 3AGSB 1/4 A 250V .25 X 1.25 IN	71400	MDL 1/4	100600	1
		FUSE POST FOR 3AG	75915	342004	102409	1
		CONN POWER MALE CH RECEPT AC W/GND	82389	EAC-301	101288	1
		PANEL REAR 405	06611	11305691	11305691	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION: FRONT PANEL ASSEMBLY #113044

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		PANEL DECOR FR 415	06811	113046	113046	1
		RES CC1/4W 30K 5%	01121	CB3035	101549	1
		1R 2W 10V WW 1 LIN	06811	112119	112119	1
		1K5K 1W 20 VC CONC LIN	06811	112105	112105	1
		RECEPT RF BNC UG-1094/U FRONT MTD	06811	UG-1094/U	101155	4
		SW TOGGLE SPDT MIN 1/4IN	09353	7101	102310	1
		KNOB NUSERT .25SHT.50.563L	21604	FS-50-21.5631	106844	1
		KNOB 23/32 BLK CONC	06811	106847	106847	3
		KNOB BLK .50.563H.1278SH6 IND	21604	PS-500-1BLK.563	106853	1
		LAMP 14V 0.3ABULB	06811	106900	106900	1
		KNOB .5 BLK 9/16H AL CAP	06811	106852	106852	1
		PANEL SUB FRONT 405	06811	113045	113045	1
		TOKEN STD. WIRE LIST	06811	113047	113047	1
	-1-	TOKEN STD. FREQ SWITCH ASSY	06811	113051	113051	1
	-1-	TOKEN STD. SWEEP/RATE SWITCH ASSY	06811	113053	113053	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION FREQUENCY SWITCH ASSEMBLY #113051

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		RES CC1/4W 1 M 5%	01121	CB1055	101605	2
		RES CC1/4W 5.1M 5%	01121	CB5155	101692	2
		1K 1/4W 1 FMF CG NA60	06811	106211	106211	2
		RES MF 10.0K .12W 1% 100PPM	19701	MF5C-D-1002-F	102096	2
		RES MF 100K .12W 1% 25PPM	06811	RN60E1003F	101967	2
		10K 1W 10 VC LIN	06811	112071	112071	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION DELAY SWITCH ASSEMBLY #37001406

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) QTY
	C91	CAPACITOR, 820 pf, 500 V	06811	106396	106396	1
	C92	CAPACITOR, .01 µf, 100 V, Mylar	27556	ZA2C103K	106410	1
	C93	CAPACITOR, .1 µf, 100 V, Mylar	06811	WMF1P1	106411	1
	C94	CAPACITOR, 1 µf, 15 V, Tant	56289	150D105X9015A	106521	1
	C95	CAPACITOR, 10 µf, 20 V Tant	56289	150D106X9020B2	100063	1
	R94	RESISTOR, Variable 50 K Mod Log	06811	112060	112060	1
	S81	DELAY SWITCH, 5 W, 6 Position	06811	112242	112242	1
		FERRITE BEAD	06811	112294	112294	1
		WIRE LIST	06811	113018	113018	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION STEP ATTENUATOR PC ASSEMBLY #11301001

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) CC STOCK NO.	(6) T/Q
	C1251	CAPACITOR, 2.5, 11 pf, 200 V, Varcer	06811	106499	106499	1
	C1252	CAPACITOR, 15-60 pf, Min. PC Mt, Varcer	72982	538-011F15-60	100234	1
	C1253	CAPACITOR, 22 pf, 500 V, 5%, Disc Mica	72136	DM15ED220J0	100068	1
	C1254	Same as C1252				
	C1255	CAPACITOR, 100 pf, 500 V, 5%, Disc Mica	72136	DM15FD101J0	100173	2
	C1256	CAPACITOR, 8000 pf, 500 V, 1 MMY AX	06811	106427	106427	1
	C1257	NOT USED				
	C1258	CAPACITOR, 5 pf, 500 V, Disc Mica	72136	DM15CD050D0	100218	1
	C1259	Same as C1255				
	R1251	RESISTOR, 5.11 M, 1%	75042	CGH 1/4	103090	1
	R1252	RESISTOR, 3.65 M, 1%	75042	CGH 1/4	103176	1
	R1253	RESISTOR, 500 K, 1/2 W, 10% VCMT 4T	06811	106146	106146	1
	R1254	RESISTOR, 887 K, 1/4 W, 1 FMF	06811	106263	106263	1
	R1255	RESISTOR, 50 K, 1/2 W, 10% VCMT 4T	06811	106145	106145	1
	R1256	RESISTOR, 88.7 K, 1/4 W, 1 FMF	06811	106262	106262	1
	R1257	RESISTOR, 5 K, 20%, 1/2 W, POT 4T	80294	3339H-1-502	102099	1
	R1258	RESISTOR, 9.76 K, 1/4 W, 1 FMF	06811	106265	106265	1
	R1259	RESISTOR, 500 Ω, 1/2 W, 10%	06811	106144	106144	2
	R1260	RESISTOR, 5.62 K, 1/8 W, 1 FMF	06811	106194	106194	1
	R1261	Same as R1259				
	R1262	RESISTOR, 8.87 K, 1/4 W, 1 FMF	06811	106261	106261	1
		TOROID CORE			112294	1
		PC BOARD, STEP ATTENUATOR	06811	113010	113010	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION WIDTH SWITCH ASSEMBLY #37001407

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
	C149	CAPACITOR, 820 pf, 500 V 1 SM AX	06811	106396	106396	1
	C150	CAPACITOR, .01 µf, 100 V, Mylar	27556	ZA2C103K	106410	1
	C151	CAPACITOR, .1 µf, 100 V, Mylar	06811	WMF1P1	106411	1
	C152	CAPACITOR, 1 µf, 15 V, Tant	56289	150D105X9015A	106521	1
	C153	CAPACITOR, 10 µf, 20 V, Tant	56289	150D106X9020B2	100063	1
	R146	RESISTOR, Variable 50 K, Mod Log	06811	112060	112060	1
	S142	WIDTH SWITCH	06811	112241	112241	1
		FERRITE BEAD	06811	112294	112294	1
		WIRE LIST	06811	113021	113021	1

REPLACEABLE PARTS LIST

EQUIPMENT/ASSEMBLY DESIGNATION SWEEP/RATE SWITCH ASSEMBLY #113053

(1) DESIGNATOR ITEM	(1) DESIGNATOR REF	(2) COMPONENT NOMENCLATURE AND DESCRIPTION	(3) MFR'S CODE	(4) MANUFACTURER'S PART NUMBER	(5) SD STOCK NO.	(6) T/Q
		SW ROT 30/7 2S 411	06811	112244	112244	1
		10K 2W 10	06811	112086	112086	1
		RES CC1/4W 2.7M 5%	01121	CB2755	101621	1
		RES CC1/4W 270K 5%	01121	CB2745	101769	1
		RES CC1/4W 27K 5%	01121	CB2735	101587	1
		RES CC1/4W 2.7K 5%	01121	CB2725	101599	1
		COUPLING 1/4D 3/4L RIGID	06811	106864	106864	1
		TOKEN STD. WIRE LIST	06811	113072	113072	1
	883037900	1				